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SEP - 9 1935

Heating · Piping and Air Conditioning

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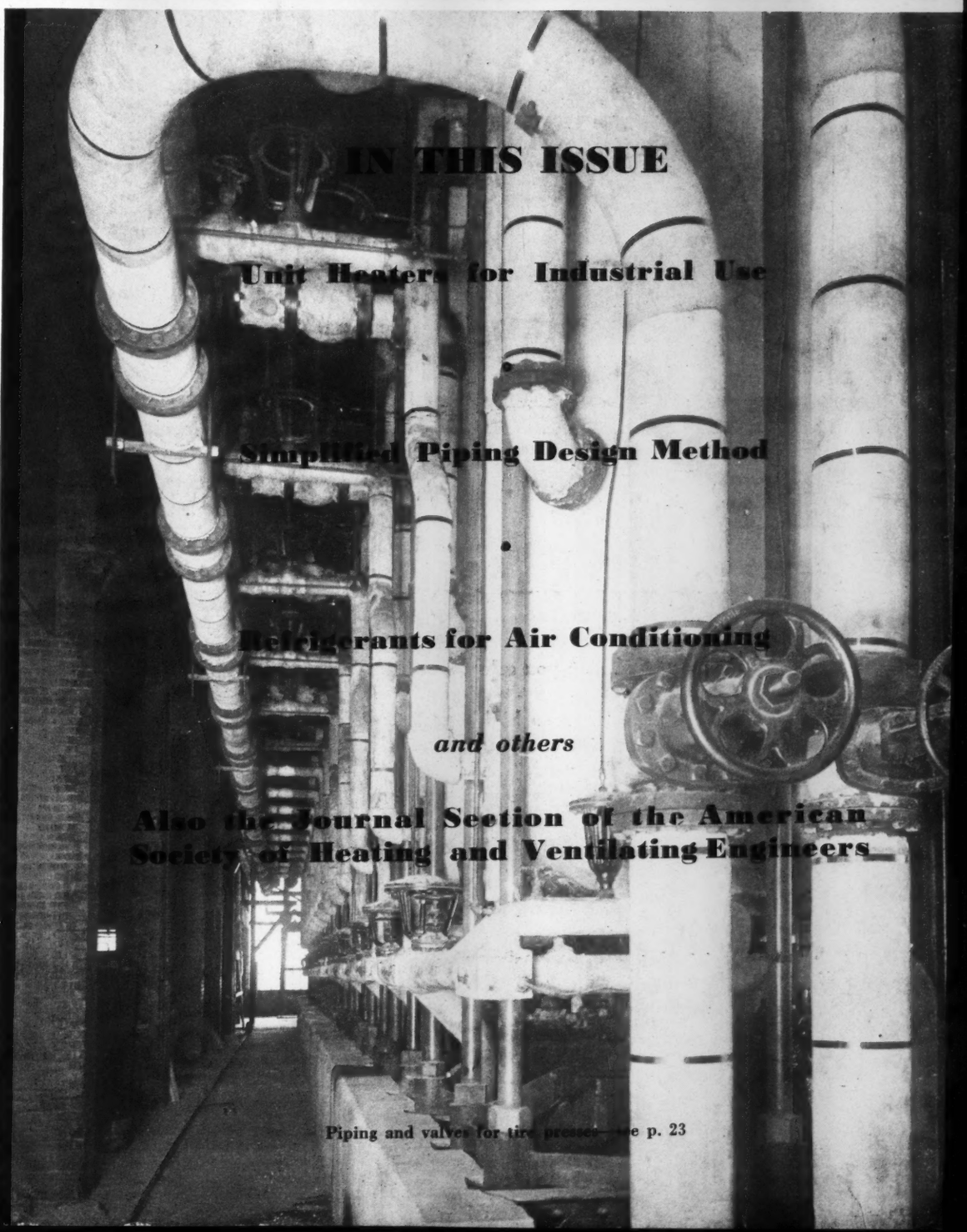
INDUSTRY AND
GE BUILDINGS

ptember, 1935



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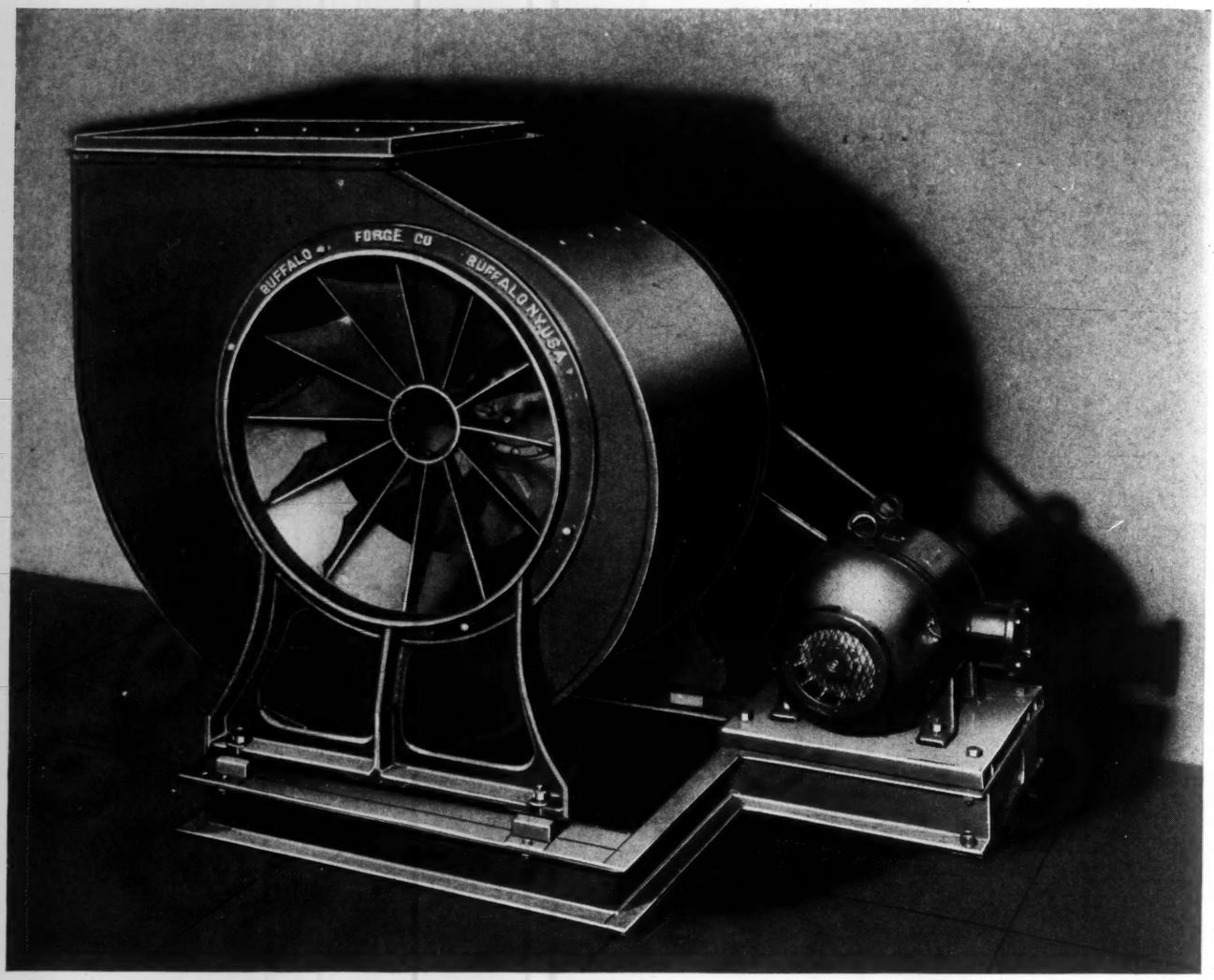

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THE EDITOR'S PAGE

● One of the first loans made under the amended National Housing Act was one for $8,500 for installation of an air conditioning and ventilating system in a 600 seat Chicago theater. The equipment includes a 20 hp compressor rated at 24 tons, provisions for circulating 14,000 cfm of conditioned air. Increased interest in the possibilities of air conditioning as a business builder have followed the extension of the loan limit to $50,000, says the FHA. . . . Revised regulations and explanatory material about the amended modernization credit plan are given in a recently published FHA booklet. Regulations were recently liberalized; lending institutions are now free to determine credit responsibility of applicants without the former arbitrary restrictions which said that the borrower must own the property to be improved in fee simple, or must at least have a legal interest in it. Also, the borrower is no longer required to have a gross annual income five times greater than the total annual payments on the insured obligation.

● Many manufacturers are promoting the modernization of plant and building heating and air conditioning systems under the FHA plan. Improvements of this kind are often "self-liquidating" in nature, either through reducing cost of operation or increasing income. Frequently, it is possible for commercial establishments to pay for air conditioning out of increased earnings resulting from the use of air conditioning, according to one manufacturer, who has recently signed a contract to provide for the long term financing of such installations.

● Here's an example of a "self-liquidating" modernization loan —A Schuyler County, New York, farmer installed an electric lighting plant, with lights in his hen house, using an FHA loan. Before modernization, the 400 hens were laying 180 eggs per day; now they lay 345. The extra eggs carry the payments, and leave a nice profit.

● The Chicago Master Steam Fitters' Association, 228 N. La Salle St., recently published an eight page circular of recommendations for mechanically circulated, high temperature hot water heating systems compiled by its standardization committee. . . . The committee feels that this method of heating offers "very real advantages" and that acceptance of its findings will encourage the reconditioning of many inefficient heating plants.

● In some respects it is a virtue to be satisfied with what you have. In others it is bad business. Piping systems are one of the latter. . . . We have in mind the complacent plant engineer who is still operating a piping system that was put in years and years ago, added to and patched up from time to time since. To hear him explain that this old system "gets by" just as well as a modern system one would think that the piping developments of recent years in materials and design might just as well have never been undertaken. He is perfectly satisfied with what he has. . . . On the other hand, a well-known consulting engineer in describing a job the other day said, "The reaction to the whole construction by an engineer not steeped in conventionality is most unfavorable." . . . There's a vast difference in the thinking of these two. We side with the latter, not because we are against conventionality but because we know that there is a very definite relationship between the piping system and plant operating and production costs.

● A reader believes that the problem facing the air conditioning industry right now is to prevent disappointments from improperly or inadequately planned installations; mechanically, the apparatus is reasonably perfect, he feels, the weakness being in the application to the specific job, with both customer and seller trying to agree on something at low cost which will do the things that air conditioning is reputed to do. . . . The question of the proper differential between indoor and outdoor temperature is a most important problem in summer air conditioning, depends a great deal upon the type of building, occupancy, etc. . . . If indoor conditions are not maintained in proper relation to outdoor, people are uncomfortable upon leaving the conditioned space, sometimes more so than if they'd never entered it. . . . A well known doctor will present his views in an early issue.

● The downtown division of the University of Pittsburgh has announced a number of evening courses in specialized fields of engineering for 1935-36. Among them are courses in heating, air conditioning and ventilation, and heat transfer instructed by F. C. Houghten, director of the A. S. H. V. E. research laboratory. . . . A special five day course in welding engineering will be conducted in Cleveland once each month through next May (except November), with day sessions at the Lincoln Electric plant and evening sessions at the John Huntington Polytechnic Institute; E. W. P. Smith, welding engineering department of the Institute, is in charge.

● Hourly wet bulb readings, often desired in connection with air conditioning work, are frequently available from airport weather stations.

● J. Frederic Byers, chairman of the board of A. M. Byers Co., announced last month that steel pipe would be manufactured in addition to the present line of wrought iron products, in the company's modern pipe mills and under the same executive supervision. . . . This is considered by the Byers organization to be another step in broadening its program of making specific recommendations as to the best pipe for a known service.

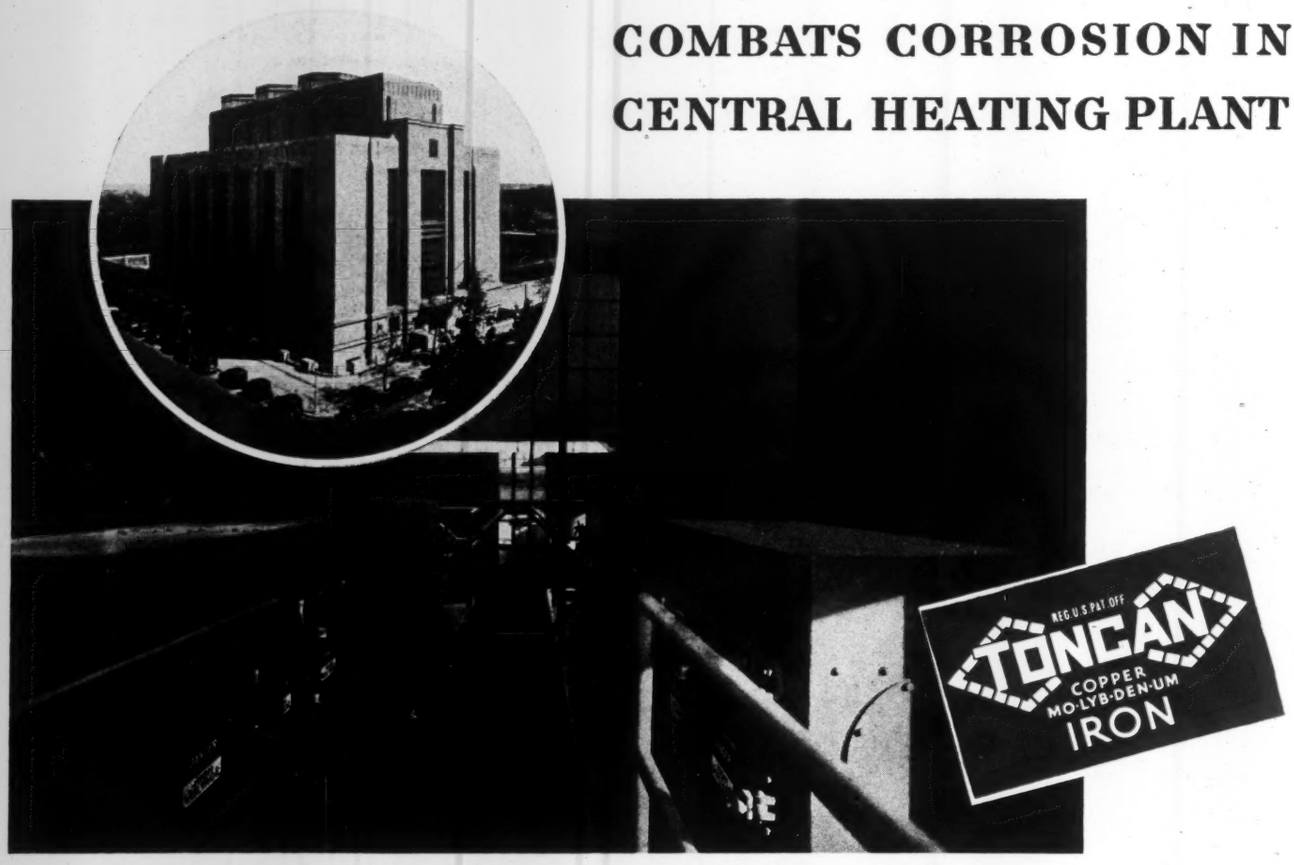
● Front cover illustration.—Seven diaphragm valves on each of these sixteen tire presses must faultlessly perform as directed by the master cycle controller on the floor above to produce perfect cures which give long mileage tires. Usually these valves are below ground level in hot, dark "pits" where, in spite of little or no maintenance, they must keep working year after year. Photo courtesy C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.

● For the first time in the history of automobile manufacturing, temperature regulation and air conditioning are being installed in machine shops and foundries. This is being done at the Ford Motor Company's Rouge factory, largest industrial plant in the world. The installation already includes 200,000 cu ft of buildings, and soon will include a further 75,000 cu ft. . . . The purpose is three-fold, according to Ford officials—to control the accuracy of fine machining operations, such as cylinder lapping; to increase the comfort of the workmen; and to protect the processes from dust and dirt. . . . Paving the way for wide and diverse utilization of molded plastic parts in fields of design and manufacture heretofore foreign to the use of such materials, a giant new press recently installed by the General Electric Co. is now being used to produce the largest plastic molding ever made in commercial quantities. The molding is used as the housing for a radically new type of weighing scale for retail merchants, which has just been announced by the Toledo Scale Co. . . . Air conditioning plays a part in the process. Since the molding powders used are almost pure white and a single speck of dirt in one loading of the compound might spoil the entire molding, an air filter system supplies clean air to main press and finishing rooms. From a bank of glass wool filters in the basement under the press room, the

[*Continued on page* 424]

Toncan Iron

COMBATS CORROSION IN CENTRAL HEATING PLANT



One of the largest Eastern central heating plants erected in recent years installed a device for the elimination of smoke. Two precipitators form the vital element in this device—the first of its kind to be installed in America.

Naturally, the builders were interested in obtaining a metal for these precipitators that would resist corrosion and give long life in this severe service where high temperature is the rule and where moisture and other products of combustion come into intimate contact with the metal. So—Toncan Iron was used—52 tons of plates for the hoppers and 62 tons of strip inside the hoppers to which the solid smoke particles adhere.

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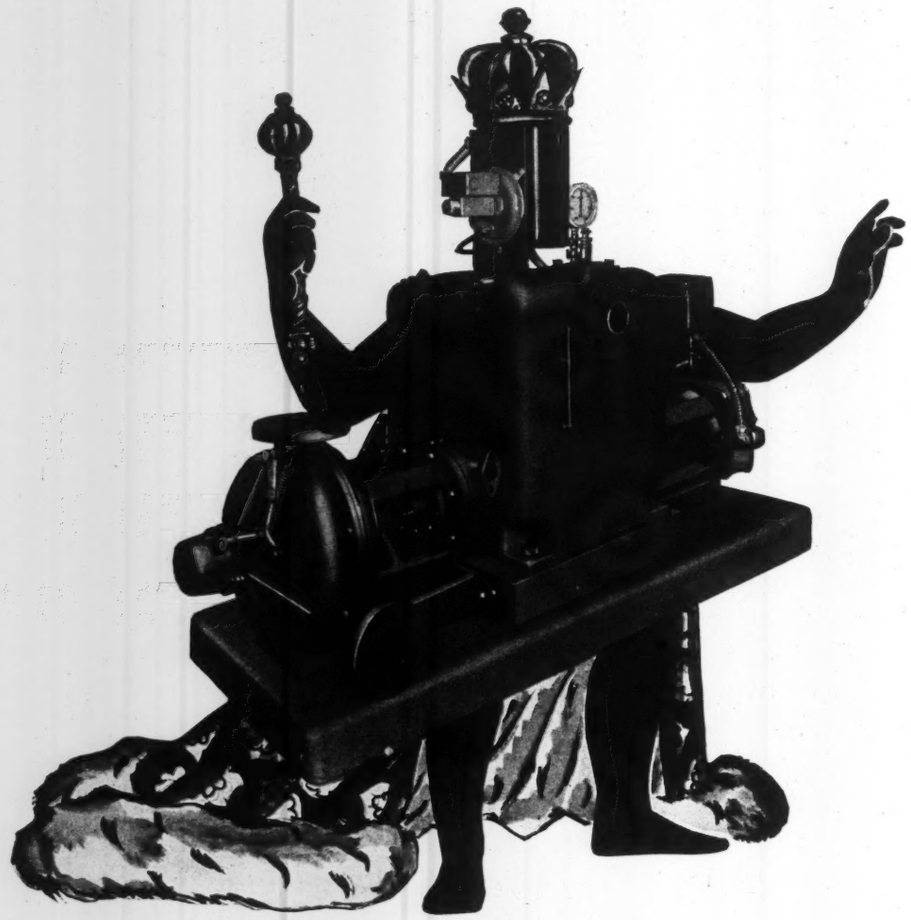
LET THIS KING OF VACUUM PUMPS PROMOTE BETTER RULE IN YOUR HEATING SYSTEM.



The Jennings Vapor Turbine is a tireless worker for better conditions in your heating plant. It promotes efficiency throughout the system. It demands little attention, and its ability to accomplish is great compared to its consumption of power. All it needs is a little steam direct from the heating lines, and that is returned right back to the heating system with small heat loss. As for electric current, the most expensive item in operating an ordinary heating pump, it requires none at all, altho it is equipped to run on electricity in any emergency.

All of this is possible because the Vapor Turbine is driven by a special turbine which needs a differential of only 5" of mercury between inlet and exhaust to function perfectly. The system may be run above or below atmosphere, and can be of any type. It makes no difference to this remarkable pump.

Now the big advantage the Vapor Turbine has is that it can operate continuously with economy. Continuous operation means continuous removal of air and condensate. Every engineer knows that uniform circulation means steam saving. That is why the Vapor Turbine can operate on steam, and still save steam as compared with a motor driven heating pump.

We could tell you a lot more about the advantages offered by this pump, and of its superior construction, but why not send for bulletin 203, and get all of the facts?

THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

Heating · Piping and Air Conditioning

Vol. 7, No. 9 September, 1935

Unit Heaters for Industrial Use

Estimating Load, Selection, Location, Control, Piping

UNIT heaters play a most important part in the heating of factories and other industrial buildings. Like many of our other newer and more recently popularized innovations, the unit heater is also susceptible to misuses and abuses, due principally to the fact that it may be considered as a panacea for all of our former heating ills. Its use, therefore, should be studied for each application, as there are a number of different kinds of unit heaters with different characteristics for various services.

It will also be found that unit heaters are not at all suitable for some services and conditions and that other methods of heating are not only more efficacious, but are necessary to the best interests of certain processes, or for human comfort. Frequently there are other functions to be performed, such as humidification, dehumidification, cooling, cleaning, dust removal, etc., which cannot be performed by the simple unit heater; in such cases the use of unit air conditioners or central systems of air conditioning is indicated, since the heating and air conditioning may thus be combined.

Generally the unit heater is cheaper to install, cheaper to operate, easier to control, quicker to heat up and gives a better distribution of heat, both horizontally and particularly vertically, than do the direct methods of heating, such as by direct radiation, pipe coils or direct fired heaters. On the other hand, the unit heater cools off quicker, is more susceptible to producing cold drafts, causes a greater air motion and produces more noise than do the direct systems of heating.

Estimating Heating Load for Industrial Unit Heaters

The heating load for industrial heating is estimated on the Btu basis, using standard transmission factors for the heat losses from walls, windows, skylights, roofs, floors, etc., and similar data for air infiltration. All of this necessary data may be found in the *American Society of Heating and Ventilating Engineers' Guide,* but there are several points pertaining to industrial heating which deserve special attention.

Temperature Gradient—

The unusual height of the stories, or more properly speaking the extreme heights from floor to roof, makes it important to consider the vertical temperature gradient in figuring the heat losses by transmission. Many conflicting claims are made as to the minimum vertical temperature gradient possible with different types of units, ranging from 0.5 F to 2 F temperature rise per ft of height from the floor to the roof or ceiling.

Other things being equal, it has been my experience that the nearer the floor a unit takes its air and the lower it delivers it the less the vertical temperature gradient will be. Likewise the nearer horizontal the air is delivered and the greater the velocity compared with the distance to which the air is to be projected the less this temperature gradient. These general principles led to the belief for a considerable period, some time ago, that the floor mounted or cabinet type of unit would produce a far less vertical temperature gradient than the suspended or radiator type of unit. This idea seems to have been somewhat exploded now, however, due no doubt to the fact that it has been found that any of the various types of units when properly located and when properly equipped with deflectors and/or recirculating ducts may be made to take air from or near enough to the floor and to return the heated air to the working zones, so as to maintain a fairly even temperature from floor to roof.

A fair average of the temperature gradient which may

By **Perry West***

The author draws on his wide experience in industrial work in presenting this "handbook" of plant heating with units.....With industrial activity on the increase and plants being modernized, factory heating needs attention.....Here is complete information on this modern method of plant heating

*Consulting Engineer, Newark, N. J.

be thus maintained with any type of unit when properly designed and installed may be taken as 0.7 F per ft in height above the point at which the normal room temperature is to be measured (either 30 in., or 60 in., above the floor depending upon whether occupants are to be seated or standing at their work). This applies for heights up to 25 ft; above this height the factor may be taken at 0.5 F per ft of height.

Air Infiltration

The next point of importance is the air infiltration or leakage.

There are usually cracks such as where sheets of iron, transite or other board forms of wall construction join each other or fit around openings or members of the construction. Factors for the air velocity through such cracks are not commonly given, but may be worked out by assuming a velocity of 500 fpm through the area of the cracks. This corresponds to a wind velocity of 15 mph, for which heat losses are generally figured unless the building is in an especially windy location.

Because of the height of industrial buildings the infiltration may be reduced for the upper portions according to the rules used for tall buildings; it should be borne in mind in this connection that in a comparatively still atmosphere the chimney effect will cause infiltration through the lower cracks and exfiltration through the upper cracks and especially through monitors. This is of little consequence in figuring the overall heat losses, however, as the slight difference in head, due to the chimney effect, is more than overcome by a 15-mile wind and, while it may reduce, it will rarely ever entirely overcome, the wind pressure even for the high cracks and ventilating sash.

Roof Losses

A third important point in figuring heat losses from industrial buildings is that the roof is usually a large factor and quite frequently of a construction for which it is not easy to find transmission factors already computed. These should be worked out very carefully, however, and the use of insulation considered as it will be found that ½ in. of insulation frequently cuts this important heat loss to about half. The roof transmission factor is all the more important for the reason that the warmest air is in contact with this surface and the temperature difference between inside and outside at this point may be from 20 to 30 F greater than nearer the floor, which means from 30 to 50 per cent greater heat loss for the same transmission factor.

Fume and Smoke Removal

Still another point deserving thought is the fact that many industrial buildings such as acid plants, dye works, foundries, forge shops, etc., require a great deal of natural ventilation in order to carry away the fumes, gases, smoke, etc. The heating of the air entering to take the place of the air thus leaving the building must be provided for. Unless special provisions are made for allowing air to enter, a fairly good way to compute the quantity of air thus entering is to figure all the cracks which may be exposed to a prevailing wind at any one time, *i. e.*, one side or two sides of a building as the conditions may warrant, for infiltration with a 15-mile wind and then figure all the remaining cracks for the chimney effect; assuming that ventilating sash in the monitors will be closed on the windward side and be subject to infiltration but be open on the leeward side and take care of the exfiltration.

After all heat losses are figured, exposure allowances of 15 per cent on the north and windward sides should be added.

If the building is to be heated regularly for 24 hours, little or no allowance may be made over and above the actual heat loss of the building.

If heating is to be done for an 8-hour day shift only, about 20 per cent should be added to the capacity of the units required for heating up quickly.

Inside Temperatures

Temperatures for which industrial buildings are usually figured are as follows:

For spaces occupied but occasionally, but where water pipes are to be kept from freezing.....40 F

For spaces where occupants are standing or moving at manual labor .....60 F

For spaces where occupants are sitting at manual labor...65 F

For spaces where occupants are sitting at clerical or light manual work .....70 to 72 F

For process rooms according to the requirements of the materials to be worked or the fluids to be kept fluent or from freezing.

Selection and Location of Unit Heaters

Before selecting unit heaters for any industrial job it should be fully ascertained as to how the air currents, noise, vibration and space requirements will affect the product or other working conditions of the plant. For instance, rooms where very light, fine powders are exposed cannot be subjected to the air currents ordinarily produced by unit heaters. The same might be true of explosive, injurious or objectionable gases or fumes. Laboratories containing delicate instruments and exposed substances are frequently better heated with direct radiation. Drafting rooms, lunch rooms and offices are frequently better heated with either direct radiation or with ventilating units, the latter furnishing both heat and fresh air. Locker rooms and showers are best heated with direct radiation, or if units are used they should be of a type that will send a blanket of warm air over the entire floor and at the same time not produce objectionable drafts against the bodies of the unclothed occupants. Any such spaces as offices, laboratories, drafting rooms, locker rooms, etc., may be best served with ventilating units, which not only furnish both the necessary heat, but also supply fresh air.

Practically all other parts of the factory may be successfully heated with most any type of unit heater; the only important requirements being that the number, size, location and duct connections must be made to suit the particular units selected.

There are a few fundamental points to be considered in connection with the selection and location of the units. Units fitted with centrifugal blowers, having long, strong blowing capacity, may be spaced so as to blow from 75 to 150 ft, while units fitted with disc or propeller type fans should be spaced so as to blow not more than 50 to 75 ft. This means, of course, that there may be fewer

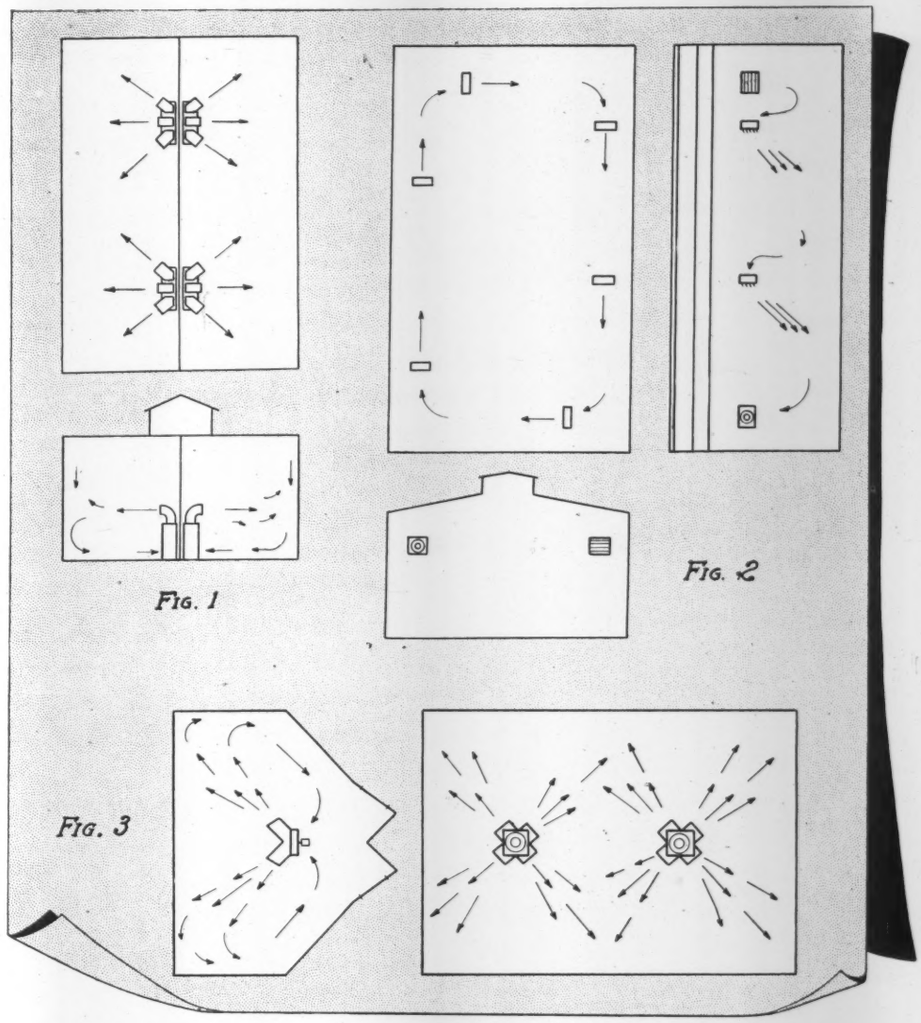


Fig. 1—Method of placing units; along inside walls or back to back near center of large space

Fig. 2—Another method of locating units; around colder walls to blow parallel with them

Fig. 3—Third method of placing units; overhead near center of large area

of the long blow units, but that they must therefore be larger than the short blow units.

There are three fundamental plans of arranging units; one is to place them along inside walls or back to back near the center of a large room, so as to blow the heated air out towards the windows and exposed walls and draw the cooler air back towards the units. (Fig. 1). It has the advantage of forcing the hot air out against the blanket of cooler air which moves downward along the exposed walls and windows, thus tending to neutralize the tendency of the hot air to rise and stratify on the ceiling and the cold air to fall and stratify along the floor. This arrangement may be followed even though the interior wall shown does not exist.

Another plan (Fig. 2) is to place the units around the colder walls, blowing parallel with these walls and wherever possible, so as to cause the warm blanket of air to circulate around the entire exposure of the building. The units with this arrangement may be floor mounted and blow out horizontally about 8 ft above the floor or may be suspended and have louvers for directing the air downward toward the floor, as shown.

The third method (Fig. 3) is to locate the units overhead near the centers of large areas in tall buildings and of smaller areas in lower stories, blowing the air outward and downward towards the floor and exposed walls. It has some advantage in taking the warm air from under an otherwise pocketed roof space, such as is shown, and forcing it back to the floor. It is also advantageous for locker and shower rooms where a warm blanket of air without horizontal drafts is desirable on the floor.

The heat output of various types and makes of units is given by the manufacturers in Btu per hr for different inlet air temperatures and different steam pressures and hot water temperatures. Care must be used in applying these tables to see that the maximum entering air temperature, corresponding to the height from which it is taken and the room temperature below, is used. Also that the lowest probable steam pressure, after allowing for loss of pressure in piping, fittings, etc., and for fluctuation in the initial pressure, is used.

In selecting and locating any type of unit it must be seen that the warm air is directed fully into and over the entire working zone and that the blow will be sufficient to cover the area between units; also, that the air movement is not interfered with by machinery or apparatus and that disagreeable drafts, including the back draft to the units, will not be created.

Methods of Temperature Control

Unit heating is very susceptible to temperature control and to an even distribution of the heat over the entire area to be covered. Thermostats should be arranged so as to control the more exposed zones, such as north and windward exposures, separately from the less exposed zones.

A good form of control is by means of a thermostat for starting and stopping the fan motors. The thermostats should be located out of the direct path of the hot

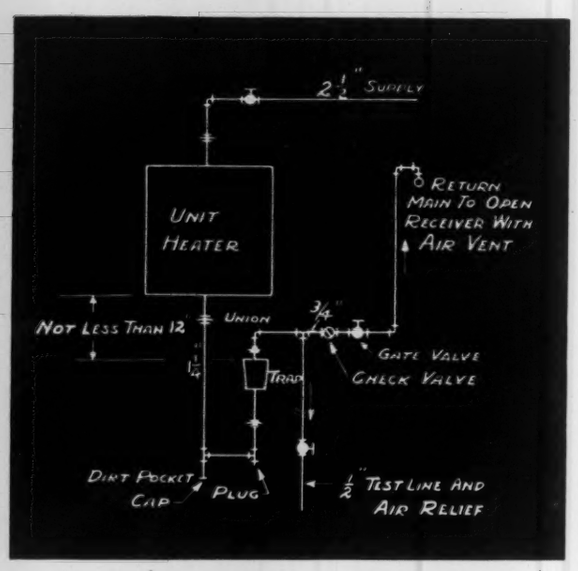


Fig. 4 — Good arrangement of return connection

air stream; a very good location is either in or near the return air inlet to the units.

The steam or hot water supply to the units may also be controlled, but when the fans are stopped substantially all heating effect is cut off, so that it is hardly necessary to control both the fans and the flow of the heating medium.

Where it is desirable to keep the air in circulation when heat is not required, the steam or hot water supply to the units may be controlled, or units that are provided with bypasses for the air around the heaters may be used, the dampers in these bypasses being controlled.

In most cases it will be found desirable to arrange the controls so the fans can be operated for air motion in summer by providing hand valves for cutting off the steam or hot water to the units and a magnetic switch with a three position button, *i. e.*, one position for automatic operation from the thermostat, one for stopping and one for starting the fans manually. In addition to the magnetic switch a fused or circuit breaker type of hand-operated main line switch must be provided for cutting the units and controls off for repairs.

Gas-fired heaters may be controlled by thermostats operating snap action valves on the gas supply. They are provided with pilot lights and should be equipped with a safety shut off valve to shut off the gas supply in case the pilot light fails. The fan motors should also be shut off by the same thermostat that shuts off the gas and be arranged so as not to start until the gas is on and the heater hot, so as to avoid cold drafts.

Supply and Return Connections

Industrial unit heaters are usually supplied with steam at plant pressures of from 5 to 100 lb, and are generally built for such pressures. The higher the pressure the higher the outlet air temperature of the units, up to a maximum of about 175 F. For offices, laboratories, lockers, lunch rooms, etc., it is best not to have outlet air temperatures above about 140 F and where accurate temperature control is desired a lower temperature around 125 F should be used.

Where zone and/or orifice control is desirable it is best accomplished with lower pressure steam, say below 5 lb. With zone control the steam may be delivered to the main zone valves at most any pressure and be automatically reduced, controlled and maintained at various pressures up to 5 lb on the low pressure side according to the weather requirements.

Where the pressure fed to the units is high enough to blow air and condensate out through the returns no special air valves are required beyond a trap that will pass both water and air, with its discharge to return mains at elevations that are not too high for the water to be discharged against the static head by the pressure in the return from the units. With such pressures the traps may be placed above the units, but it is always better practice to have traps about a foot below the bottom of the unit so the condensate will drain by gravity to the trap.

The return should be full size to a dirt pocket and have a trap inlet taken from a point above this pocket. A good arrangement of such a return connection is shown in Fig. 4. The condensate from supply branches may be taken directly through the units, but long mains should be separately dripped through traps.

When the supply pressure to the units is less than 5 lb or where the air cannot be disposed of through the returns it is necessary to use some other means of disposing of the air. If the returns are open or otherwise not under pressure, the air may be disposed of through these returns with the condensate. If the returns are under pressure the air must be disposed of through automatic air valves on the returns from each radiator. Fig. 5 shows a good arrangement for a low pressure system with open returns.

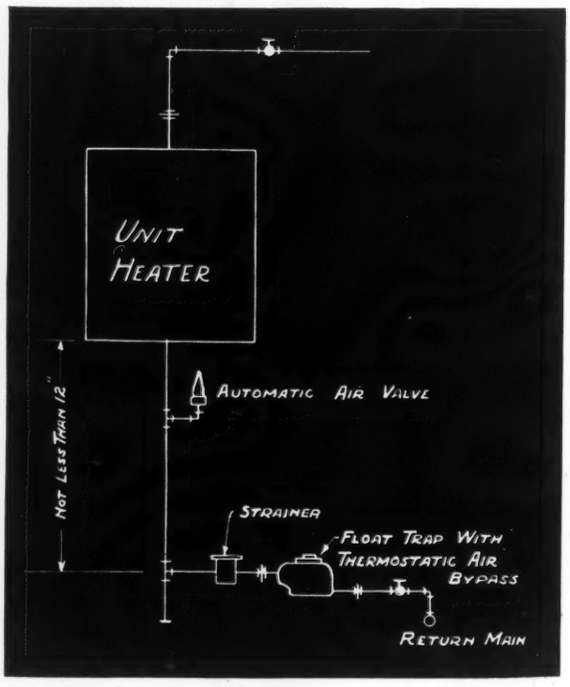
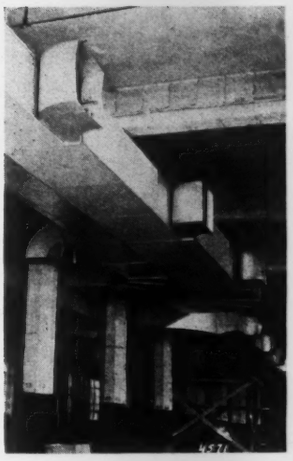


Fig. 5—Good arrangement for low pressure system with open returns

Air Conditioning Frees Rotogravure Plant from Weather Hazards



Duct work being installed

By **H. E. Jacobsen***

IN the rotogravure printing industry, quality of the product is of utmost importance. So that proper register may be obtained with the application of the colors, etching with acid, and retouching to improve, very exact control of temperature and humidity is necessary. Here, then, is an air conditioning problem of the highest order—to provide atmospheric conditions exactly suited to each phase of the handling and manufacture of this sensitive process, no matter what the weather, to assure high speed production of a uniform and difficult to standardize procedure. An interesting example of such an installation is the system recently put in at the plant of Alco Gravure, Inc., Chicago.

Proper and definite humidity with very slight variations was the first consideration, because constant regain of moisture means constant paper stretch and perfect registering of multicolor impressions. The sensitiveness of the carbon tissue to moisture regain, because of its great absorbing qualities, demands of this system definite humidity and dry bulb temperature the year around. Variations not to exceed 1¼ F dry bulb are desirable and variations of 1 to 3 per cent in relative humidity are considered excessive. Careful analysis indicated the following as the most desirable conditions:—

Etching Department	72 F D.B.	with	50% R.H.
Photo Gallery	74 F D.B.	"	50% R.H.
Retouching Department	75 F D.B.	"	50% R.H.
Sensitizing of Carbon Printing	72 F D.B.	"	50% R.H.
Dark Rooms	74 F D.B.	"	50% R.H.
Drying Room	75 F D.B.	"	50% R.H.

Six Condensing Units Provide Flexibility

Considerable thought was given to the possibility of cutting operating expense while accomplishing the desired results. The refrigeration required is the difference of the total heat of the mixed fresh air and recirculated air and the total heat at the determined saturation, or dew point, which in this instance is the equivalent of 60 tons. Obviously as the fresh air temperature decreases, so does the total heat of the mixture and consequently the amount of refrigeration necessary to reach saturation. It was therefore decided to install six 10 hp, 10 ton condensing units for flexibility and economy.

Further to assure economy in operation multiple evaporators were installed. A total of twenty 3 ton evaporators were arranged within the main air conditioning chamber in banks of two deep, five high and two wide. Each evaporator was designed for a minimum pressure drop and carefully balanced between sensible and latent heat capacity. Thus, as the compressor and evaporator requirement decreases, automatic refrigerant control is provided in that part of the air will pass through the evaporators not in use, with the balance of the air passing over the cooled surfaces of the required evaporators.

Air Cycle and Distribution

It has been mentioned that the mixture of fresh and recirculated air is brought to a saturated state, which because of the conditions to be maintained in the plant was determined as 52.2 F dew point. The desired leaving air temperature and condition under the peak operation was computed to be 60 F D.B. and 60 per cent R.H. Because of the possibility of only one or two departments being in operation, with the others temporarily inactive, means had to be provided to overcome changes in internal heat gain. In other words, as the heat gain decreases beyond that estimated, heat must be provided so as to maintain the constant temperatures desired. Therefore booster heating coils were installed in the branch ducts leading to each department, the control of which is described later.

Humidifying apparatus of both the steam and water spray type was installed in the main coil casing, the spray type intended for summer use and the steam grid type for winter.

Reheat coils were also installed in the coil casing to raise the temperature of the air leaving the evaporators to the desired leaving air temperature of 60 F for peak conditions in any department.

Proper air distribution and diffusion is of as much importance in the design of such a system as is the tem-

Close control of temperature and humidity and thorough diffusion of the conditioned air feature the recently installed air conditioning system at this rotogravure printing plant. Six 10 ton condensing units and twenty 3 ton evaporators provide flexibility to promote operating economy with varying refrigeration demands

*Chief Air Conditioning and Automatic Heat Engineer, North Central Region, Frigidaire Corp., Chicago, Ill.

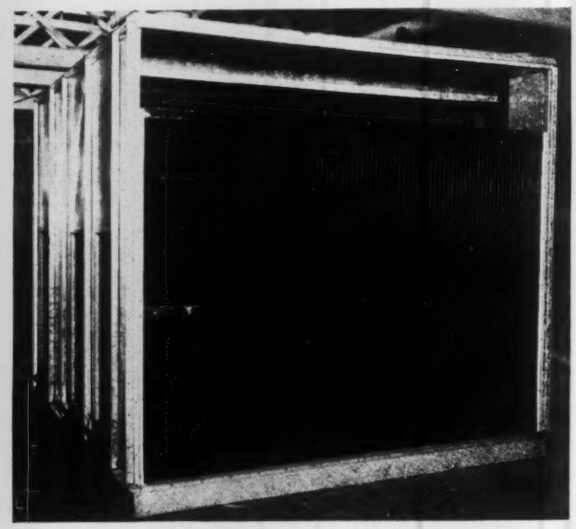
perature regulation arrangement. It was found that where conditions require no variations throughout the entire conditioned area, a minimum of air movement is necessary. To accomplish this, it was decided to supply air through several diffusion type supply outlets at an unusually low velocity, returning this air to the ceiling directly behind the supply outlets. This system requires 21,000 cfm of conditioned air to be circulated. A slow speed quiet operating supply fan was selected and was set to discharge the air into the main trunk supply ducts at a velocity not to exceed 1000 fpm which permits an outlet velocity at the grille of approximately 300 fpm.

Smoke tests were made and because of the perfect distribution, it was difficult to determine the spread of the smoke, which proved conclusively during the test that the air was distributing as calculated.

Temperature and Humidity Control

A temperature and humidity control system of the pneumatic type is used. Each department has its individual thermostat controlling a diaphragm steam valve on the booster heating coil. To assure "hair-line" control, thermostats of the all metal type with bimetal thermal elements which could be calibrated on the job were selected. The humidistats are connected to an electro-pneumatic switch and arranged so that when the air conditioning system is shut down, the humidifiers automatically shut off. The humidistats are connected to both the spray type humidifier and the steam grid humidifier.

Group of air eliminator plates fabricated by the sheet metal contractor for the Alco Gravure job. Because of the high moisture condensing ability of the evaporators, four pass eliminators were necessary to insure removal of entrained moisture



The entire cycle of the temperature regulation is as follows: The fresh air and return air ducts are automatically controlled by means of automatic balancing dampers which in turn are controlled from a thermostat in the mixing air stream preceding the air filters. After the air has been properly filtered, it passes through the multiple evaporators, the refrigerant being controlled from the dew point thermostat set at the 52.2 F saturation point. This thermostat is connected to a stage and sequence control panel which has a graduated dial for each solenoid valve and which may be set to bring that particular solenoid valve into operation in any predetermined sequence with regard to the other valves. With this method of control, the solenoid valves may be operated one at a time, at any sequence or may be operated together in groups in any sequence. In this way, a very flexible control is obtained in a manner that prevents rapid fluctuations in fan discharge temperature, and naturally shows its effects on the savings in operating costs by calling for only as many compressors as required.

After the air leaves the evaporators, its moisture content may be too low due to entering mixed air being low, and the sprays or grid humidifiers begin to function as demanded by the respective humidistats. The air then leaves the humidifying chamber and passes through a reheat coil which is controlled from an immersion type thermostat located at the inlet side of the supply fan. This thermostat is set at 60 F dry bulb which is the dry bulb temperature determined in the calculations dependent upon the quantity of air handled to pick up the sensible heat gain. The air is then discharged by means of the supply fan into the main trunk ducts leading to the various departments. Each of these trunk ducts is provided with booster heaters which are controlled from thermostats located in the respective departments.

The booster heaters, reheaters, sprays and evaporators are in operation both summer and winter as required to maintain the final desired dry bulb temperature and relative humidity. In other words, this system will always require some refrigeration, even during the coldest winter days.

Zimmerman, Saxe and MacBride were the architects for the project and the sheet metal contractor was Herbert H. Davis Co. The engineering was done by the author's office.

Editor's Page—

[*Continued from page 23, front section*]

air is discharged into the rooms through an air supply duct having openings of such design as to prevent turbulence which might scatter the powdered molding compound. . . . The *Chicago Tribune*, which has devoted considerable attention to publicizing its air conditioned headquarters in the Tribune Tower, has announced that its employees' building and loan association will make loans to finance the installation of air conditioning in employees' homes, with the thought that those who have experienced air conditioning during working hours will want it at home.

● C. F. Hill and E. V. Erickson, under the direction of Chief Engineer L. L. Lewis of the Carrier Engineering Corp., have developed a graphic method of determining the profit to be derived from the installation of air conditioning in an office building. Called the "Office Building Econograph," it is a chart on which may be plotted the yield from air conditioning based on known factors relating to the present and anticipated rental situation and the estimated cost of operating and owning an air conditioning plant. . . . A sharp rise in interest in air conditioning from banks and other financial institutions has been noted by E. S. Chapman of Airtemp, Inc. . . . Banking and financial houses are finding that air conditioning is an economical method of providing year round comfort and increasing personnel efficiency, he says.

A Simplified Method for Solving Piping Problems

By **Siegfried W. Spielvogel*** *and* **Samuel Kameros†**

A simplified method for checking an assumed piping layout for the intensity of end reactions and the determination of bending moments is presented here... Unsymmetrical lines require individual treatment, and this procedure gives exact results in comparatively short time. It will be welcomed by those conversant with other methods as a means for checking results obtained

THE design of a pipe line subjected to temperature variations should attempt to meet the stress limitations of the material with use of the least amount of material. Under ordinary conditions, economical layouts can often be obtained without resorting to expansion loops but by merely joining the terminal points of the line with straight branches and rectangular bends or, when dictated by clearance requirements, with bends made of a combination of straight and curved units.

The most important and time consuming work is in the checking of an assumed layout for the intensity of the end reactions and the determination of the bending moments along the line. The restraining actions of the end supports prevent the line from expanding freely and force it to assume an involuntary shape. This results in internal stresses the intensities of which depend upon the flexibility of the pipe line; that is, on the ease or difficulty with which the piping adjusts itself to a new condition of temperature or load. Flexibility depends upon the size of the pipe, its length and the shape of the line. Insufficient flexibility may cause failure or leakage; excessive flexibility means loss of space and unnecessary expenditures of labor and material.

It is evident that a well balanced design which satisfies stringent requirements for safety and economy of space and material cannot be obtained by applying simple rules-of-thumb, especially where wide temperature variations enter the problem as in the case of high pressure steam piping. Such problems must be solved by methods of scientific analysis.

The reactions for the majority of practical or symmetrical bends can be obtained from existing charts or diagrams in handbooks or catalogs. Unsymmetrical lines, however, require individual treatment for which a number of methods are available; the one described here will give exact results in relatively short time. Those who are conversant with other procedures will welcome another means for checking results obtained by the method to which they have become accustomed.

It is not the intention here to discuss the distribution and combination of stresses; the reader is referred to the "Piping Handbook" by Walker and Crocker, Chapter VII.[1]

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Determining End Reactions

The procedure in determining the end reactions of a fully restrained pipe line subjected to thermal expansion involves six distinct steps which will be discussed in detail and illustrated by a number of numerical examples.[2]

First: Determine the center of gravity of the pipe line. This is done as follows: The length of each pipe branch is multiplied by the distance of its own centroid from an arbitrary axis. The sum of all products is divided by the total length of the line. The result is the distance of the centroid from the assumed axis. Repeat procedure using an axis at right angle to the former obtaining the distance from the second axis. The two results give the position of the centroid of the line. (The location of the center of gravity of curved branches is found from a figure to appear with the second part of this article. The meaning of the factor K, called the flexibility constant, is explained in the problem dealing with curved branches.)

Second: Assume one of the two end supports (for instance, A, Fig. 1) temporarily released so as to obtain a free cantilever fixed at B, and connect A with the centroid O by means of a rigid bracket. If the pipe line is now subjected to a thermal expansion or any kind of loading, point O will go through the same movements as support A and if the line is assumed to be fixed at O, it will distort in the same way as if it were fixed at A. Having recognized this fact, the problem resolves itself in determining the reactions at O.

[1]Published by McGraw-Hill Book Co., New York, N. Y.
[2]For proofs and theory the reader is referred to p. 165 of the May, 1935, *Transactions* of the *American Society of Mechanical Engineers.*

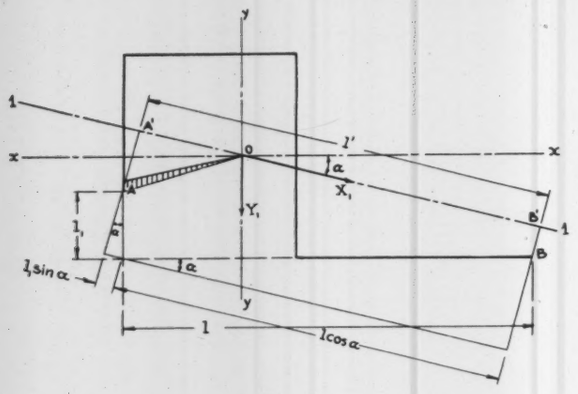


Fig. 1

Through point O we pass two rectilinear axes, for instance, a horizontal axis x-x and a vertical axis y-y and calculate the moments of inertia I_{xx} and I_{yy} and the product of inertia I_{xy}.

The moment of inertia of a straight branch which is parallel to the axis under consideration is its length multiplied by the square of the distance from that axis. The moment of inertia of a straight branch at right angle to the axis is one-twelfth of the third power of its length plus the length times the square of the distance between the centroid of the branch and the axis.

The product of inertia I_{xy} for a straight branch parallel to an axis is the length of the branch multiplied by the coordinates of its centroid.

For the moments of inertia and product of inertia of inclined branches see figure to be published with second part of this article.

Third: Assume the reactions at point O acting in the following directions: One force Y_1 vertically, *i. e.* in direction of axis y-y, the other X_1 in the direction of an axis 1-1 which is inclined to the horizontal at an angle $\propto$ found from the equation:

$$\tan \alpha = \frac{I_{xy}}{I_{yy}}$$

At point O the moment of restraint due to uniform temperature change is zero.

Fourth: Calculate the modified moment of inertia I_{11} from the formula:

$$I_{11} = I_{xx} - 2 \tan \alpha I_{xy} + \tan^2 \alpha I_{yy}$$

I_{xx}, I_{yy} and I_{xy} are introduced in the foregoing equation with positive signs.

Fifth: Determine the expansion movements of O in directions 1-1 and y-y as if this point were the end of a free cantilever fixed at B. These movements are:

(a) For pipe supports at same level:

$$\triangle x_1 = c\, l \cos \alpha \triangle t$$
$$\triangle y = 0$$

(b) For pipe supports at different levels:

$$\triangle x_1 = (l \cos \alpha + l_1 \sin \alpha)\, c \triangle t$$
$$\triangle y = l_1\, c \triangle t$$

c denotes the coefficient of expansion.

$\triangle t$ the temperature change and l and l_1 the horizontal and vertical distances respectively between and supports A and B. See Fig. 1.

Sixth: Find the reactions at point O from the following equations:

$$X_1 = \frac{EI \triangle x_1}{I_{11} \cos^2 \propto}$$

$$Y_1 = \frac{EI \triangle y}{I_{yy}}$$

E denotes the modulus of elasticity of the pipe material corrected for temperature.

I denotes the moment of inertia of the cross-section of the pipe.

The actual reactions are found by transferring X_1 and Y_1 to A. In addition point A is under the effect of a moment which is due to the offset of O to A. In order to simplify calculations, the inclined force X_1 is first resolved into a horizontal and vertical component. Let the horizontal and vertical components of the reaction at A be designated respectively by X and Y. Then:

$$X = X_1 \cos \alpha$$
$$Y = Y_1 + X_1 \sin \alpha$$

Examples

The following example will illustrate the method:

Pipe is 6 in.—600 lb Standard Seamless Pipe.
Steam temperature = 750 F.
Room temperature = 60 F.
Coefficient of expansion,[3] c = 6.14 in. per 100 ft.
Moment of inertia of cross section of pipe, I = 37 in.^{4}
Modulus of elasticity, $E = 25.5 \times 10^6$ lb/sq in.
Supports on the same level (Fig. 2)

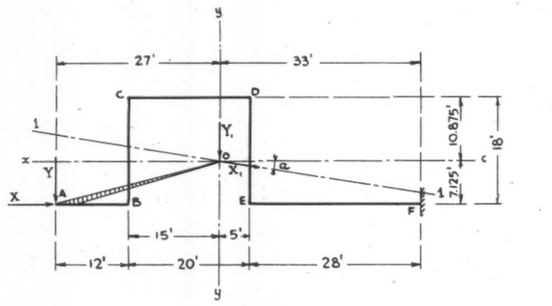


Fig. 2

First: Determine the center of gravity of the pipe line:

Pipe branch	Length l	Distance of centroid from left end a	lxa	Distance of centroid from top b	lxb
$A\,B$	12 ft	6 ft	72	18	216
$B\,C$	18	12	216	9	162
$C\,D$	20	22	440	0	0
$D\,E$	18	32	576	9	162
$E\,F$	28	46	1288	18	504
	$\Sigma l = 96$		$\Sigma la = 2592$		$\Sigma lb = 1044$

$$\text{Distance from left end} = \frac{2592}{96} = 27 \text{ ft}$$

$$\text{Distance from top} = \frac{1044}{96} = 10.875 \text{ ft}$$

[3]For linear expansion of steel pipe and modulus of elasticity at different temperatures see p. 344 and for moment of inertia of standard steel pipe sizes see p. 345; July, 1933, Heating, Piping and Air Conditioning.

Second: Moment of inertia and product of inertia:

Pipe Branch	I_{xx}			I_{yy}		
AB	12×7.125^2	=	609.2	$\frac{12^3}{12} + (12 \times 21^2)$	=	5436
BC	$\frac{18^3}{12} + (18 \times 1.875^2)$	=	549.3	18×15^2	=	4050
CD	20×10.875^2	=	2365.3	$\frac{20^3}{12} + (20 \times 5^2)$	=	1166.7
DE	Same as BC	=	549.3	18×5^2	=	450
EF	28×7.125^2	=	1421.4	$\frac{28^3}{12} + (28 \times 19^2)$	=	11937.3
	I_{xx}	=	5494.5	I_{yy}	=	23040.0

	I_{xy}			
AB	$12 \times (-7.125) \times (-21)$	=	+	1795.5
BC	$18 \times 1.875 \times (-15)$	=	−	506.3
CD	$20 \times 10.875 \times (-5)$	=	−	1087.5
DE	$18 \times 1.875 \times 5$	=	+	168.8
EF	$28 \times (-7.125) \times 19$	=	−	3790.5
	I_{xy}	=	−	3420

Third:

$$\tan \alpha = -\frac{3420}{23040} = -0.1484$$

$$\alpha = -8^\circ\ 26'\ 20''$$

Fourth:

$$I_{11} = I_{xx} - 2 \tan \alpha\ I_{xy} + \tan^2 \alpha\ I_{yy}$$

$$= 5494.5 - 1015.06 + 507.34 = 4986.78$$

Fifth: Expansion movements:

$$\triangle x_1 = cl \cos \alpha\ \triangle t \qquad \triangle y = 0$$

$c \triangle t = 6.14''$ in 100 ft

$l \cos \alpha = 60' \times 0.9892 = 59.352$

$$EI = \frac{25.5 \times 10^6 \times 37}{144} = 6.552 \times 10^6 \text{ lb ft}^2$$

$$EI \triangle x_1 = 6.552 \times 10^6 \times \frac{6.14}{12} \times \frac{59.352}{100} = 1{,}989{,}850$$

Sixth: Reactions at O:

$$X_1 = \frac{EI \triangle x_1}{\cos^2 \alpha\ I_{11}} = \frac{1{,}989{,}850}{0.9785 \times 4986.78} = 407.8 \text{ lb}$$

$$Y_1 = \frac{EI \triangle y}{I_{yy}} = 0$$

Reactions at A:

$X = X_1 \cos \alpha = 407.8 \times 0.9892 = 403.4$ lb

$Y = X_1 \sin \alpha = 407.8 \times 0.1468 = 59.9$ lb

Bending moments:

at A	$(403.4 \times 7.125) + (59.9 \times 27)$	$= +4491.5$ ft lb
B	$(403.4 \times 7.125) + (59.9 \times 15)$	$= +3772.7$ ft lb
C	$(-403.4 \times 10.875) + (59.9 \times 15)$	$= -3488.5$ ft lb
D	$(-403.4 \times 10.875) + (-59.9 \times 5)$	$= -4686.5$ ft lb
E	$(403.4 \times 7.125) + (-59.9 \times 5)$	$= +2574.7$ ft lb
F	$(403.4 \times 7.125) + (-59.9 \times 33)$	$= +897.5$ ft lb

Note that since the location of the center of gravity of the pipe line depends upon the location of the loop, the slope of the conjugated axis and therefore the magnitudes of the reactions also depend upon the location of the loop.

The following problem will illustrate the method for the case of a pipe supported at different levels. The procedure is identical to that followed in the preceding problem. In Step 5, however, the expansion movement Δy is not zero. The result is a force Y_1 which is added to the vertical component of X_1 to obtain the total vertical reaction Y. Pipe dimensions and other conditions are the same as in the preceding problem.

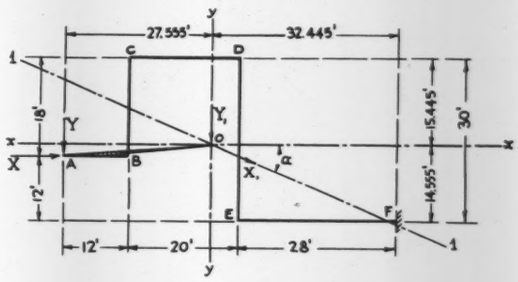


Fig. 3

First: Center of gravity of pipe line.

Pipe branch	Length l	Distance of Centroid from left end a	lxa	Distance of Centroid from top b	lxb
AB	12 ft	6 ft	72	18 ft	216
BC	18	12	216	9	162
CD	20	22	440	0	0
DE	30	32	960	15	450
EF	28	46	1288	30	840
	108 ft		2976		1668

Distance of centroid from left end $= \frac{2976}{108} = 27.555$ ft

Distance of centroid from top $= \frac{1668}{108} = 15.445$ ft

Second: Moment of inertia and product of inertia:

Pipe Branch	I_{xx}			I_{yy}		
AB	12×2.555^2	=	78.4	$\frac{12^3}{12} + (12 \times 21.555^2)$	=	5,719.4
BC	$\frac{18^3}{12} + (18 \times 6.445^2)$	=	1,233.7	18×15.555^2	=	4,355.2
CD	20×15.445^2	=	4,771.0	$\frac{20^3}{12} + (20 \times 5.555^2)$	=	1,283.8
DE	$\frac{30^3}{12} + (30 \times 0.445^2)$	=	2,255.9	30×4.445^2	=	592.8
EF	28×14.555^2	=	5,931.7	$\frac{28^3}{12} + (28 \times 18.445^2)$	=	11,355.4
	I_{xx}	=	14,270.7	I_{yy}	=	23,306.6

	I_{xy}			
AB	$12 \times (-2.555) \times (-21.555)$	=	+	660.9
BD	$18 \times 6.445 \times (-15.555)$	=	−	1,804.5
CD	$20 \times 15.445 \times (-5.555)$	=	−	1,715.9
DE	$30 \times 0.445 \times 4.445$	=	+	59.3
EF	$28 \times (-14.555) \times 18.445$	=	−	7,517.1
	I_{xy}	=	−	10,317.3

Third:

$$\tan \alpha = \frac{I_{xy}}{I_{yy}} = -\frac{10{,}317.3}{23{,}306.6} = -0.4426$$

$$\alpha = -23^\circ\ 52'\ 30''$$

Fourth:

$$I_{11} = I_{xx} - 2 \tan \alpha\, I_{xy} + \tan^2 \alpha\, I_{yy}$$

$$= 14{,}270.7 - 9{,}132.9 + 4{,}565.7 = 9{,}703.5$$

Fifth: Expansion movements:

$$\triangle x_1 = (l \cos \alpha + l_1 \sin \alpha)\, c \triangle t$$

$$l \cos \alpha + l_1 \sin \alpha = (60 \times 0.9145) + (12 \times 0.4047) = 59.726 \text{ ft.}$$

$$EI\, \triangle x_1 = \frac{25.5 \times 10^6 \times 37}{144} \times \frac{6.14}{12} \times \frac{59.726}{100} = 2{,}002{,}388$$

$$\triangle y = l_1\, c\, \triangle t \qquad l_1 = 12 \text{ ft}$$

$$EI\, \triangle y = \frac{25.5 \times 10^6 \times 37}{144} \times \frac{6.14}{12} \times \frac{12}{100} = 402{,}315$$

Sixth: Reactions at O:

$$X_1 = \frac{EI\, \triangle x_1}{\cos^2 \alpha\, I_{11}} = \frac{2{,}002{,}388}{0.8363 \times 9703.5} = 246.75 \text{ lb}$$

$$Y_1 = \frac{EI \triangle y}{I_{yy}} = \frac{402315}{23{,}306.6} = 17.26 \text{ lb}$$

Reactions at A:

$$X = X_1 \cos \alpha = 246.75 \times 0.9145 = 225.6 \text{ lb}$$

$$Y = Y_1 + X_1 \sin \alpha = 17.26 + (246.75 \times 0.4047) = 117.1 \text{ lb}$$

Bending moments:

At A $(225.6 \times 2.555) + (117.1 \times 27.555) = +3{,}804$ ft lb
At B $(225.6 \times 2.555) + (117.1 \times 15.555) = +2{,}397$ ft lb
At C $-(225.6 \times 15.445) + (117.1 \times 15.555) = -1{,}663$ ft lb
At D $-(225.6 \times 15.445) - (117.1 \times 4.445) = -4{,}006$ ft lb
At E $(225.6 \times 14.555) - (117.1 \times 4.445) = +2{,}764$ ft lb
At F $(225.6 \times 14.555) - (117.1 \times 32.445) = -516$ ft lb

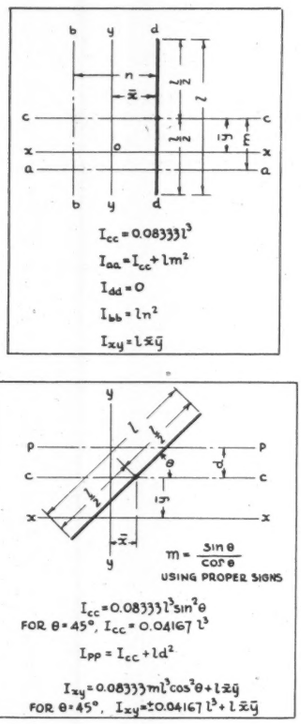

$I_{cc} = 0.08333 l^3$
$I_{aa} = I_{cc} + lm^2$
$I_{dd} = 0$
$I_{bb} = ln^2$
$I_{xy} = l\bar{x}\bar{y}$
$m = \frac{\sin\theta}{\cos\theta}$
USING PROPER SIGNS
$I_{cc} = 0.08333 l^3 \sin^2\theta$
FOR $\theta = 45°$, $I_{cc} = 0.04167\, l^3$
$I_{pp} = I_{cc} + ld^2$
$I_{xy} = 0.08333 ml^3 \cos^2\theta + l\bar{x}\bar{y}$
FOR $\theta = 45°$, $I_{xy} = \pm 0.04167\, l^3 + l\bar{x}\bar{y}$

Fig. 4.

[In a second article the authors will present two additional problems dealing with inclined and curved branches and also a number of tables which permit the calculation of the moments of inertia and products of inertia for the majority of arcs used in pipe design—EDITOR].

Flue Gas Analysis for Hotel Heating Plant

A Reader's Question ● We have a portable Orsat flue gas analyser, but have no information as to the proper percentage of different gases that we should get. Our readings are as follows:

Carbon dioxide	0.128
Oxygen	0.192
Carbon monoxide	0.193

We have an 80 hp water-tube boiler and an underfeed stoker. The forced draft fan connected directly with the stoker runs continuously while the stoker is running. This boiler supplies steam for the hotel and, in summer, uses 1500 lb of coal a day, operating about 18 hr per day; the stoker runs five minutes out of every twenty minutes. In the summer this steam is used to heat the hot water for the hotel and furnish steam for the dining room and coffee shop kitchen.

What amount of different gases should we have, or get, with efficient operation? What changes in the draft or fuel bed or damper regulations are necessary to increase the efficiency over these results?—S. E. B., Managing Director.

Answer—

To the uninitiated there must be something terribly wrong with the combustion or with the analysis, but it develops that on the contrary things are really excellent considering that the load is so light that the time of stoker operation averages only five minutes out of each twenty minutes.

To one familiar with an Orsat instrument, the values given above are not indicative of the exact conditions but need to be separated, as follows:

Carbon dioxide, 0.128, or nearly 13 per cent, not at all bad for the conditions stated.

Oxygen, 0.192—0.128, or 0.064, again excellent.

Carbon monoxide, 0.193—0.192, or 0.001; remarkably good.

There is still some excess air which might be reduced by leak-sealing the masonry of the setting or by reducing slightly the volume of air delivered by the forced draft fan in proportion to the coal delivery or by approaching very closely to a balanced draft through the fire doors. SAMUEL R. LEWIS.*

*Consulting Mechanical Engineer, Chicago, Ill. Member of Board of Consulting and Contributing Editors.

AIR CONDITIONING FUNDAMENTALS

Total Heat—Entropy Charts for Refrigerants

Theory of the compression refrigeration cycle is briefly covered here, with formulas and charts to facilitate use of the data....This is probably the largest collection of total heat—entropy charts which has ever appeared in one publication . . *By* Louis A. Harding*

A FAIRLY clear conception of the refrigeration cycle is necessary if one is to understand the complete air conditioning problem. The two indispensable tools used by the thermal engineer in analyzing the effects produced by various changes in the state of a vapor media by certain assumed processes are the general energy equation for steady flow, and total heat-entropy charts.

The so-called Rankine closed operating cycle for a simple condensing steam power plant is similar, in many respects, to the compression refrigerating cycle.

The liquid is continuously evaporated in a boiler (power plant) or evaporator (refrigerating plant) and in either case the liquid absorbs heat. In the first case, the heat for evaporation is supplied by fuel and in the latter case the necessary heat is abstracted from the higher temperature media (air or liquid) surrounding the evaporator coil surfaces.

The vapor (steam) leaving the boiler is passed to a reciprocating engine or turbine (power plant) where it is expanded to the lower condenser pressure, performing external work. The vapor leaving the evaporator (refrigerating plant) passes to a power driven compressor which compresses the vapor, raising the pressure to the pressure maintained in the condenser. The vapor becomes superheated during compression.

The condensed liquid leaving the condenser, in the steam plant, is pumped back into the boiler and in a refrigerating plant flows through a reducing valve (expansion valve) back into the evaporator. No pump is required in this case, as the pressure in the evaporator is always less than the pressure maintained in the condenser.

General Energy Equation

The general energy equation for steady flow is founded on the basic law of conservation of energy. Assuming a steady flow through a system, the energy in all forms flowing past an assumed Section 1 of a conduit must obviously be equal to the total energy flowing past a subsequent Section 2, plus or minus the energy of various kinds imparted to or abstracted from the media flowing.

Each kind of energy represented with liquid, gas or vapor flow is measured above some assumed datum, at which level the energy is assumed as zero. The datum point used in each case is immaterial, as the engineer is concerned only with differences rather than absolute quantities.

It is assumed in the following discussion that no chemical change of state occurs.

The four kinds of energy represented at any flow section, each measured in ft lb per lb of flowing media, are as follows (see Fig. 1):—

Energy of Position is the weight (1 lb) times the height, z ft above some elevation datum or z ft lb per lb. It is the potential energy of the media by virtue of its position above some assumed elevation datum.

Kinetic Energy is the work required to accelerate 1 lb of the media from a state of rest to velocity, w ft per second or $(w^2/2g)$ ft lb per lb. The datum is zero velocity.

Flow Energy or energy in transit is the product of the absolute pressure P in lb per sq ft and the specific volume v (cu ft per lb), or Pv ft lb.

The heat equivalent is $Pv/778$ Btu per lb. (1 Btu = 778 ft lb). It is the energy entering a section of conduit by reason of the entry of the media against the existing pressure. It is obviously the external work performed by the vapor during evaporation in overcoming the maintained pressure in the vapor generator and is not a part of the internal heat energy of the vapor.

Internal Heat Energy. The internal heat, i Btu per lb, includes the heat content of the liquid q, plus the heat required to overcome the molecular attraction when evaporation takes place. This quantity is ordinarily not tabulated in the vapor tables, but may be readily determined, if desired, by subtracting $Pv/778$ from the tabulated total heat h, or $i = h - (Pv/778)$ or $h = i + (Pv/778)$ Btu per lb.

For superheated vapor an additional term $c\ (t_x - t_s)$ Btu per lb must be included in the value for h. c = mean specific heat of the vapor for the temperature and pressure, range. t_x and t_s are the temperatures of the superheated vapor and saturated vapor respectively. The datum for water vapor is 32 F and for refrigerants is —40 F.

The total heat (h) of either wet, dry, saturated or super-

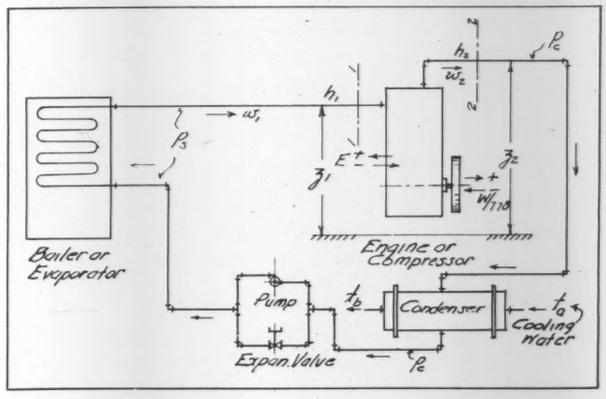


Fig. 1—The Rankine cycle

L. A. Harding Construction Corp., Buffalo, N. Y.

heated vapor and also the liquid heat for various pressures and corresponding temperatures may be read direct from a total heat-entropy chart for the media being considered. The charts shown are plotted with total heat and entropy for the co-ordinates.

Entropy, in so far as this discussion is concerned, may be defined as the ratio of the total heat added to the media to the absolute temperature at which it is added.

The total energy in ft lb, represented at sections 1 and 2, is:—

$$z_1 + \frac{w^2_1}{2g} + i_1/778 + P_1 v_1 \text{ and } z_2 + \frac{w^2_2}{2g} + i_2/778 + P_2 v_2$$

Let $\pm E$ = heat imparted (—) to or abstracted (+) from the media between Sections 1 and 2, Btu per lb.

$\pm W$ = work performed on (—) or by (+) the media between Sections 1 and 2, ft lb per lb.

According to the conservation law, we may then write the general equation for steady flow as,

(For the flow of a liquid media, the temperature remaining constant, $i_1 = i_2$, resulting in Bernoulli's equation as employed in all hydraulic computations and for air flow at practically constant pressure and temperature in duct systems in which $z_1 = z_2$).

The equation is perfectly general and may be applied to any section of conduit through which steady flow is taking place, as, for example, the inlet and outlet to any piece of apparatus comprising the refrigerating plant, steam plant, etc.

For all practical purposes, in this connection, $z_1 = z_2$ and $w_1 = w_2$.

Adiabatic Expansion or Compression

We assume, for convenience, that expansion of the vapor (power plant), or compression of the vapor (refrigerating plant), takes place in a non-conducting cylinder, no heat being transferred to or from the media by conduction through the cylinder walls ($E/778 = 0$). Expansion or compression taking place in this manner is

$$z_1 + \frac{w_1^2}{2g} + i_1/778 + P_1 v_1 = z_2 + \frac{w_2^2}{2g} + i_2/778 + P_2 v_2 \pm \frac{E}{778} \pm W \quad \ldots\ldots\ldots\ldots\ldots (1)$$

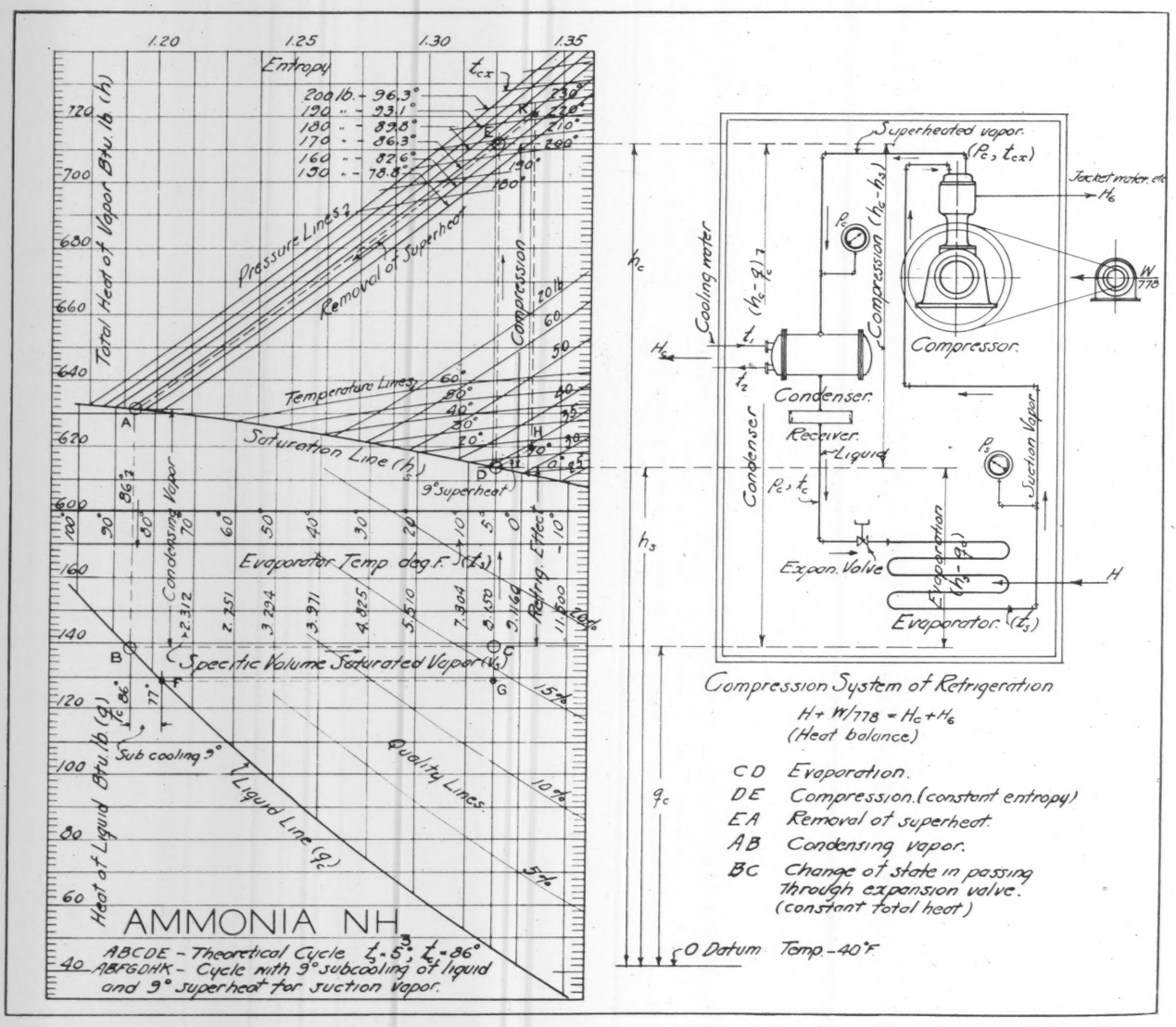


Fig. 2—Total heat—entropy chart for ammonia, with diagram of refrigeration cycle indicating use of chart

commonly termed "adiabatic." The process is reversible and the entropy (vertical lines on charts) remains constant during the process.

Substituting h for $i + (Pv/778)$ in each case (Eq. 1) and assuming compression of the vapor with $h_1 = h_s$ total heat for entering vapor and $h_2 = h_c$ total heat for leaving vapor, the general energy equation (1) then reduces to,

$$W = \frac{h_c - h_s}{778} \text{ ft lb per lb media compressed} \quad \ldots\ldots (2)$$

Work has been performed on the vapor and assuming the entering vapor to be dry saturated it will leave compressor in a superheated condition.

Knowing the temperature and corresponding pressure condition of entering vapor, h_s is read direct from the chart for the refrigerant to be used, then the vertical entropy line is followed to its intersection with the pressure line corresponding to the pressure to be maintained in the refrigerant condenser and the value of h_c is read.

Throttling Process

The flow of the liquid from the condenser to the evaporator is controlled by a throttle, pressure reducing or commonly termed "expansion valve," either automatic or hand controlled. The process is assumed adiabatic ($E = 0$). In this case no work is performed ($W = 0$) and the total heat (q_c) per lb remains constant. The entropy is increased and the process is irreversible. A small portion (usually 10 to 15%) of the liquid is flashed into vapor, reducing the temperature t_c of the liquid, leaving condenser to the evaporator temperature t_s.

Refrigerating Effect and Weight of Refrigerant (M_x) to Be Circulated Per Minute

It is customarily assumed that the vapor leaving the evaporator is dry and saturated with a total heat h_s Btu per lb corresponding to the temperature (t_s) to be maintained in the evaporator.

It is ordinarily assumed that the initial temperature of the liquid being evaporated corresponds to the temperature (t_c) of saturated vapor at the pressure (p_c) maintained in the condenser with heat content of q_c Btu per lb. The liquid, however, may be and sometimes is "subcooled" below the temperature t_c to t'_c with heat content q'_c.

H = Heat to be absorbed by evaporator, Btu per min.
T = Tons refrigeration (200 Btu per min) = $H/200$.
$h_s - (q_c \text{ or } q'_c)$ = heat absorbed per lb of refrigerant, Btu (refrigerating effect).

$$\text{Then } M_x = H/h_s - q_c = \frac{200\ T}{h_s - q_c} \text{ lb per min} \quad \ldots\ldots (3)$$

Power Input to Compressor

The theoretical hp (1hp = 42.5 Btu per min) required for compressing the vapor from Eq. 2 is,

$$\text{Theor. hp} = \frac{M_x\ (h_c - h_s)}{42.5} \quad \ldots\ldots (4)$$

In the actual compressor, the compression is not strictly adiabatic and power is consumed in friction removed by the jacket water, etc.

Let ϕ = overall potential efficiency based on adiabatic compression, then,

$$\text{Expected hp} = \frac{M_x\ (h_c - h_s)}{42.5\ \phi} \quad \ldots\ldots (5)$$

ϕ varies with the compression ratio, size and design of compressor, speed, etc. A value of $\phi = 0.75$ may be assumed for preliminary estimates.

It was assumed above that the vapor at the beginning of compression was dry and saturated; actually the vapor is more often in a superheated state, approximately 5 to 10 F above the saturation temperature, corresponding to the suction or evaporator pressure.

If one desires to take this into account when using the charts, follow the intersection of the pressure line (p_s) corresponding to the evaporator temperature (t_s) with the "saturation line" until the pressure line (p_s) intersects the temperature line 5 to 10 F above the evaporator temperature (t_s). Follow the vertical constant entropy line to its intersection with the condenser pressure line (p_c) and read the corresponding total heat (h_c) of the superheated vapor leaving the compressor.

Compressor Displacement

The volume (V) of assumed saturated vapor entering the compressor per min is; $V = M_x\ v_s$ in which v_s = specific volume in cu ft per lb of saturated vapor at temperature t_s.

To allow for some superheating of this vapor passing through the compressor suction valves and the re-expansion of the compressed vapor retained in the clearance space, the expected compressor displacement required is approximately,

$$D = \frac{M_x\ v_s}{0.75} \text{ cu ft per min.}$$

Heat Removed by Condenser (H_c) and Weight of Cooling Water (C) Required

The heat to be removed per minute is,

$H_c = H + M_x\ W/778$ Btu. $H = M_x\ (h_c - q_c)$

Then $H = M_x\ [(h_c - h_s) + (h_s - q_c)] = M_x\ (h_c - q_c)$ Btu per min.

The amount is, evidently, the sum of the heat absorbed by the evaporator, plus the heat equivalent of the work of compression.

The weight of cooling water (C) required per minute is,

$$C = \frac{M_x\ (h_c - q_c)}{t_b - t_a} \text{ lb per minute, in which } t_a \text{ and } t_b \text{ are the}$$

initial and final temperatures of the cooling water entering and leaving the condenser. t_b may be assumed as 5 to 10 F below temperature t_c of the condensed liquid leaving condenser.

Total Heat-Entropy Diagrams

The chart for ammonia was plotted from the tabular values published by the U. S. Bureau of Standards *Bulletin* No. 142. The charts for carbon dioxide, methyl chloride and sulfur dioxide were plotted from values as read from either charts or tables published in the *A. S. R. E.* Data Book, 1935 Edition. The chart for freon was plotted from the tabular values for this refrigerant

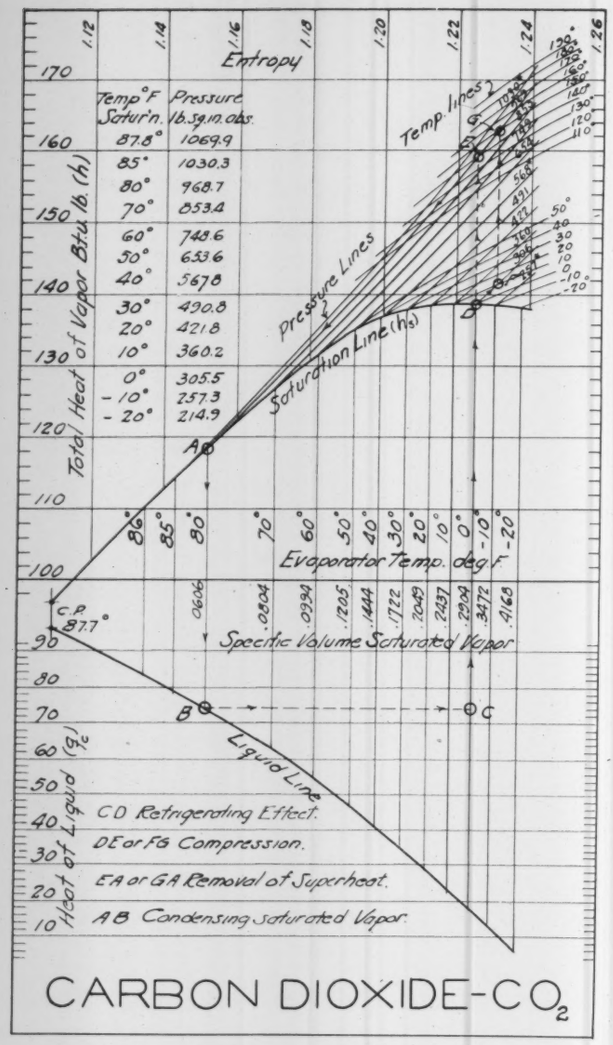


Fig. 3

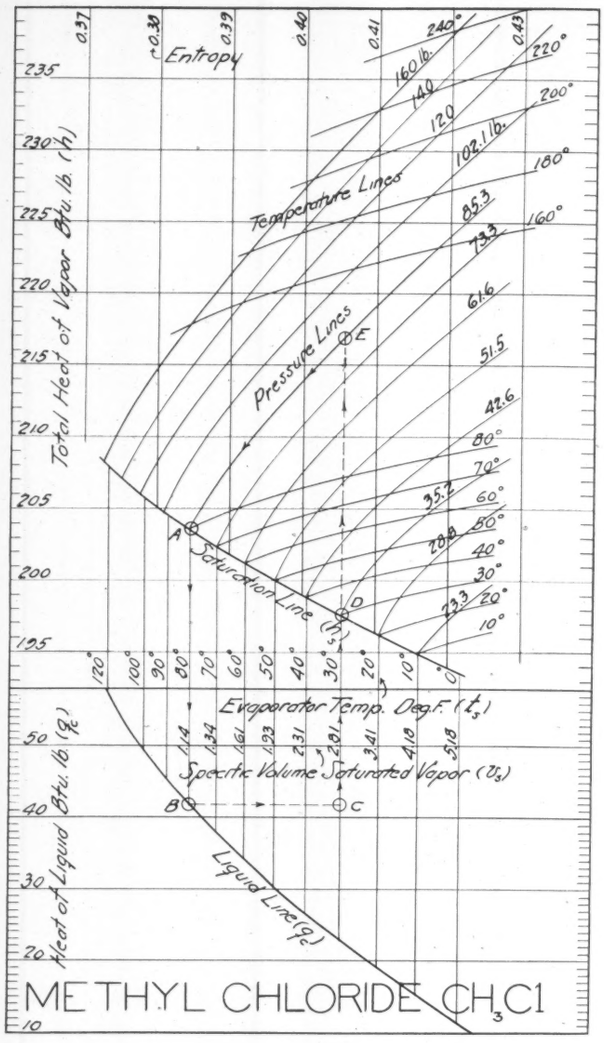


Fig. 4

Total heat—entropy charts for four refrigerants

Fig. 5

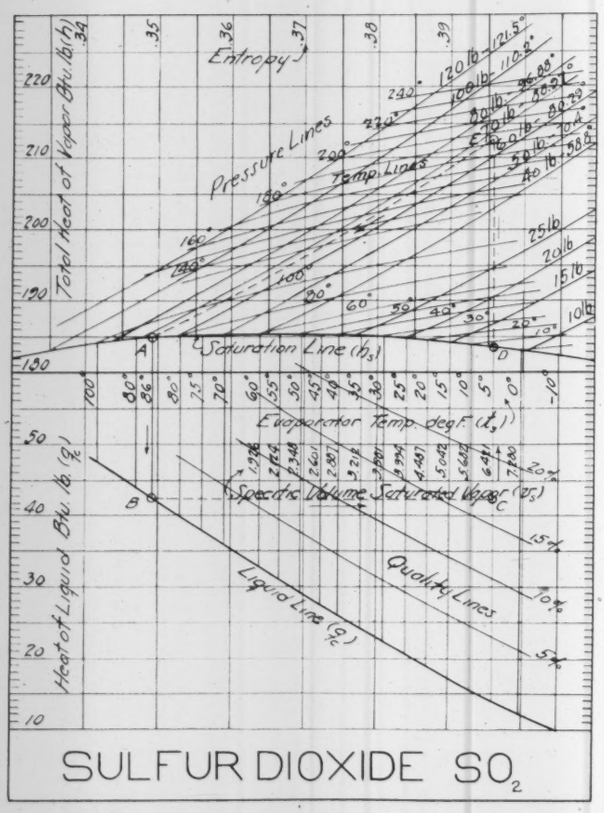
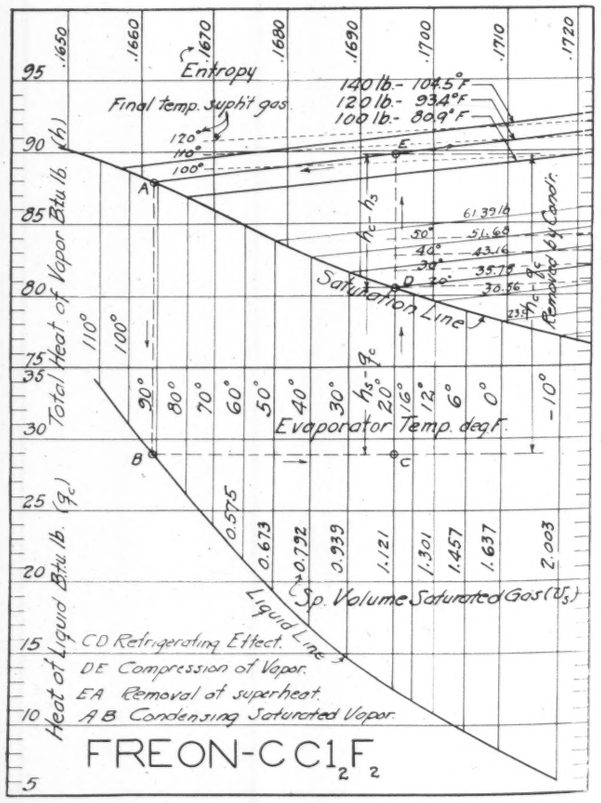


Fig. 6



by R. M. Buffington and W. K. Gilkey, *A. S. R. E.* Circular No. 12.

The theoretical cycle, without sub-cooling and superheat for the suction vapor for $t_s = 5$ F and $t_c = 86$ F is indicated on the charts as *A, B, C, D, E*. The cycle, when both sub-cooling of the liquid and superheat of suction vapor is taken into account, is indicated on the ammonia chart for $t_s = 5$ F and $t_c = 86$ F as *A, B, F, G, D, H, K*.

In this example for ammonia, without sub-cooling or superheat for the suction vapor, $q_c = 138.9$; $h_s = 613.3$; $h_c = 712$; $v_s = 8.15$. The weight of vapor to be pumped in lb per min per ton of refrigeration is,

$$M_x = \frac{200}{613.3 - 138.9} = 0.421 \text{ lb, and volume } V = 0.421 \times 8.15$$

$= 3.43$ cu ft per min per ton.

$$\text{The theoretical hp per ton} = \frac{0.421\ (712 - 613)}{42.5} = 0.99.$$

With 9 F sub-cooling and 9 F superheat for the suction vapor, the temperature of liquid is 77 F and the temperature of the superheated suction vapor at beginning of compression is 14 F.

Then, $q_c = 128.5$; $h_s = 613.3$; $h'_s = 618.7$ at beginning of compression; $h_c = 720.6$; $v_s = 8.15$

Weight of refrigerant to be circulated per min per ton,

$$M_x = \frac{200}{613.3 - 128.5} = 0.412 \text{ lb}$$

The volume of vapor to be handled by the compressor, which determines the displacement required, must now be based on the volume of the superheated vapor at a temperature of 14 F and suction pressure corresponding to evaporator temperature of 5 F. It is necessary to refer to the superheated tables or a more complete chart of the refrigerant for the value of the specific volume, which in this example is approximately, $v'_s = 8.25$ cu ft per lb.

$$\text{This is an increase of } \frac{8.25 - 8.15}{8.15} = 0.012 \text{ or } 1.2$$

per cent in the compressor displacement based on the previous assumption that the vapor is saturated at the beginning of compression.

$$\text{The theoretical hp per ton} = \frac{0.412\ (720.6 - 618.7)}{42.5} = 0.987$$

As would be expected, the weight and volume of refrigerant to be pumped with sub-cooling is less by approximately 2 per cent.

The percentage *increase* in the power required with 9 F superheat for the suction vapor is evidently,

$$\frac{(720.6 - 618.7) - (712 - 613.3)}{712 - 613.3} = 0.032 \text{ or } 3.2 \text{ per cent}$$

It is here assumed that the vapor leaves the evaporator in a dry saturated condition at temperature t_s, the superheat being added to the vapor as it passes through the hot compressor valves and passages.

The charts cannot be read with sufficient accuracy to make a true comparison between the different refrigerants and should not be employed for this purpose.

The increase of superheat of suction vapor by 10 F reduces the capacity of the compressor by approximately 1 per cent and increases the hp per ton by approximately 3 per cent.

The increase of condenser temperature by 10 F increases the hp per ton by approximately 15 per cent.

The increase in evaporator temperature by 10 F increases the "tons capacity" by approximately 10 per cent and decreases the hp per ton by approximately 15 per cent.

[This is the second of a series of articles on air conditioning by Mr. Harding. The first, published in the July issue, discussed the items in comfort cooling design, and was supplemented by a selection chart for cooling coils in the August number.—Editor.]

Estimating Approximate Cost and Capacity of Air Conditioning

THE following average figures for approximating the capacity and cost of air conditioning installations were given by E. B. Murray of E. B. Murray & Co., Kansas City, in his paper on air conditioning presented at the Cincinnati convention of the *National Association of Building Owners and Managers*. He pointed out that unusual circumstances entering into the installation will materially affect cost and capacity, but that correct factors to meet special cases can be applied to obtain at least a rough check. These figures, stated the speaker, have been applied in estimating a number of installations which were later checked and found to be correct within a small degree of variation:

To Estimate Tonnage Required—

Offices and Banks—0.3 ton per 100 sq ft.

Restaurants—One patron per 15 to 20 sq ft, to which must be added the number of employees.

0.1 ton per person.

Stores—0.325 tons per 100 sq ft. (Factor is higher on account of heavy light load and frequency with which doors are opened.)

To Estimate Costs of Installation

Cost per ton for above ranges from $250.00 to $350.00 or for

Offices and Banks—$1.00 per sq ft.

Restaurants—$1.30 to $1.50 per sq ft.

Stores—$1.15 to $1.50 per sq ft.

Operation Costs

Consumption—

1 kw per hour per ton.

1 to 1½ gpm water per ton.

Approximately 25c to 30c per day (ten hours) per ton total operations (electricity and water).

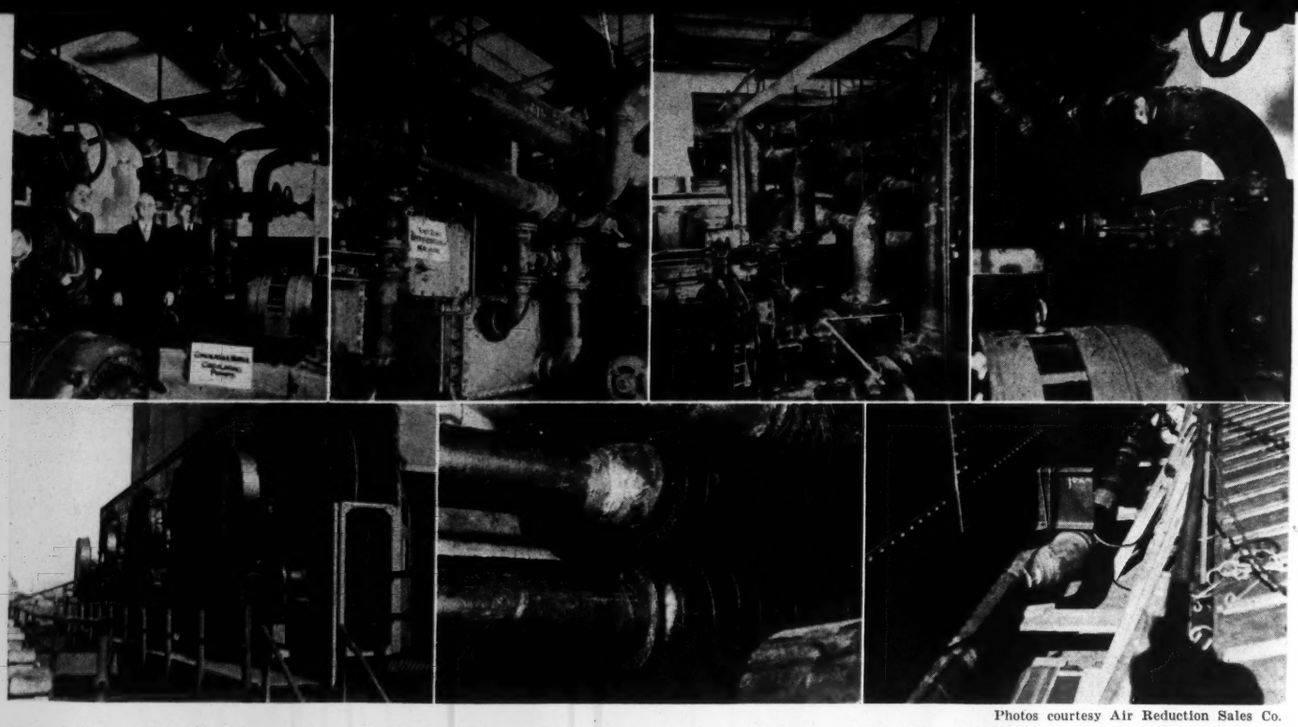
Repairs, renewals, labor not included.

A break down of the average installation cost is as follows—

Duct Work	25%
Fans and apparatus	35%
Refrigeration, coils, compressors	35%
Controls	5%
	100%

Another simple rule for determining the approximate tonnage required for various classifications, is as follows:

Types of Rooms	Cu Ft per Ton
Cafeterias and Lunchrooms	1000 to 1500
Barber and Beauty Shops	1200 to 1800
Dining Rooms and Retail Stores	1500 to 2000
Theatres	1800 to 2400
General Offices, Club Rooms, Funeral Parlors	2000 to 3000
Banks, Broker's Offices, Private Offices and Residences	2500 to 4000

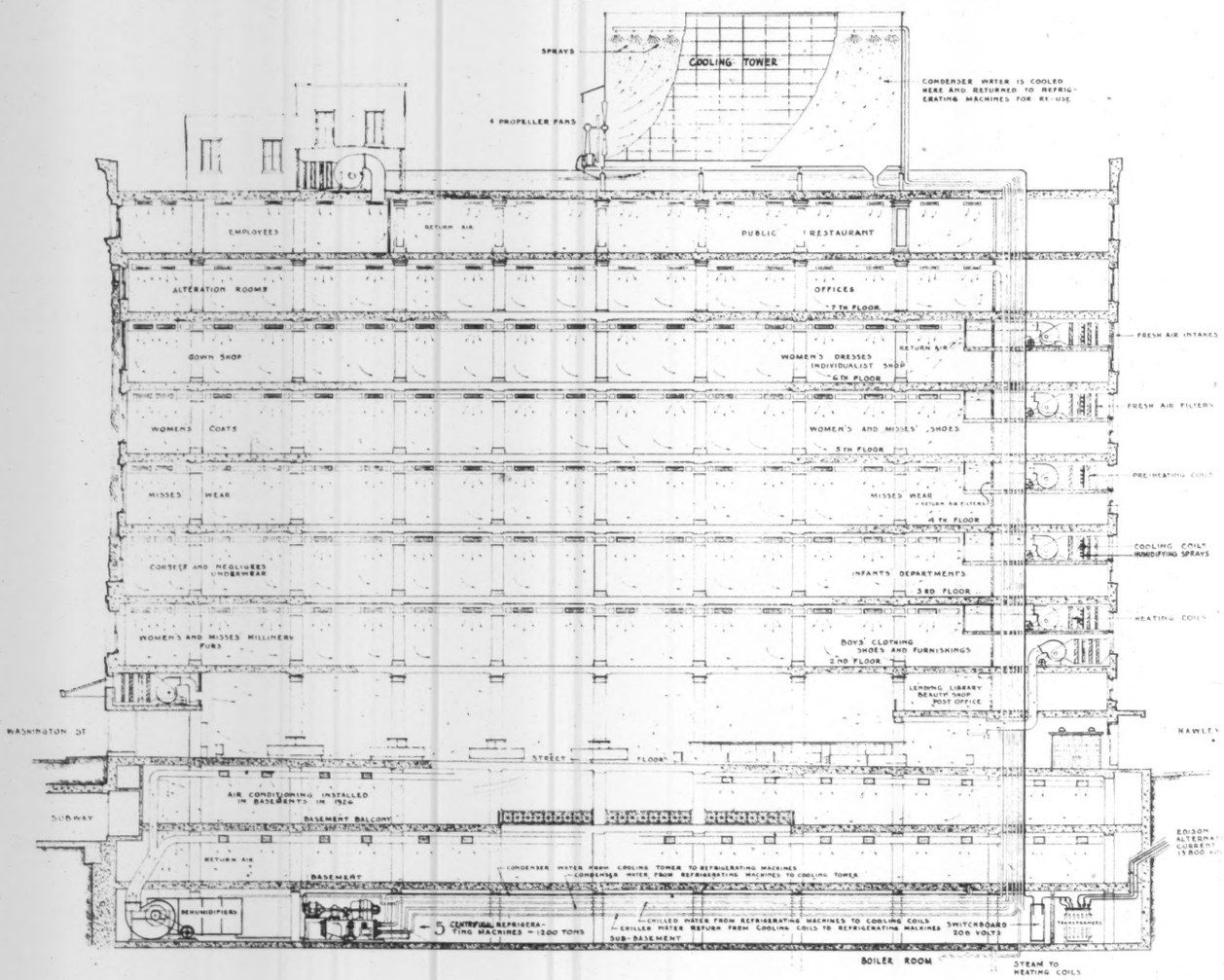


Photos courtesy Air Reduction Sales Co.

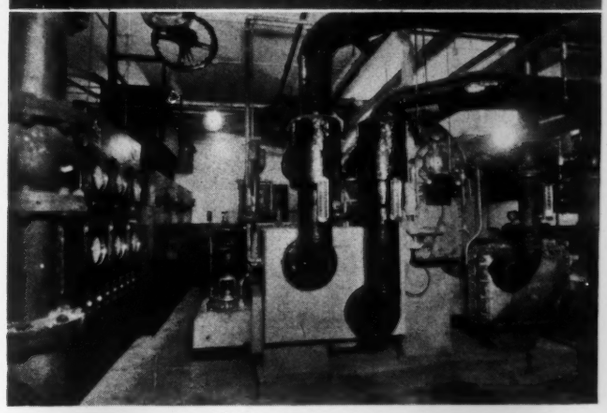
Top, left to right—Circulating lines, 14, 12, 10, 8, 6 and 3 in. sizes . . . Lines leading from refrigerating machines and circulating pumps, sizes 14, 12, 10, 8, 6, 5, and 3 in., with offsets, reducers and welding ells . . . Another view of the lines from the refrigerating machines and circulating pumps . . . Tight nest of bends

Bottom, left to right—The 3,600 gpm cooling tower on the roof, showing the fans, motors, and drives . . . The cork covering progressing following hydrostatic testing of the piping at 145 lb per sq in . . . Vertical offset or bend leading from the supply tank and cooling tower on roof.

Filene's—famous Boston department store—is completely air conditioned, 1200 tons of refrigeration being required. To adapt the equipment to available space, separate conditioning apparatus supplied with chilled water from centrifugal compressors in the basement serves each floor



By **Richard Brunel*** *with* **Francis A. Westbrook**



At right—Above, construction view showing duct installed and temporary scaffolding. Below, one of the refrigerating machines and the control panel

Air Conditioning Modernizes Filene's

BECAUSE the management feels that a department store can render no greater service to its patrons and employees than to provide comfortable indoor conditions regardless of the weather and crowds, Wm. Filene's Sons Company, Boston, has invested $400,000 in complete air conditioning for its building. Supplementing the installation for the basement made in 1926, the new addition for the eight floors of the building (318,000 sq ft) brings the refrigeration capacity up to 1,200 tons; 18,000,000 cu ft per hr of conditioned air is circulated, providing for three air changes per hr. Design was based on an occupancy of 8,100 persons, maintenance of 80 F dry bulb and 50 per cent relative humidity in summer with an outdoor dry bulb of 90 F and wet bulb of 75 F. In winter, 40 per cent relative humidity will be maintained.

This job, one of the first completely air conditioned department stores as well as one of the largest, presented a number of problems because the installation was made in an existing building in restricted space without interrupting business. The cross-sectional elevation of the building shows the manner in which the equipment was installed.

The five centrifugal refrigerating machines in the basement have a total capacity of 1,200 tons, two of the three new ones having a capacity of 300 tons each, and the third 150 tons. Chilled water is supplied from them to air conditioning units on the various floors; this arrangement was necessary because of available space and it also reduced the amount of space required for ducts, as vertical runs are eliminated. Each floor has one conditioning unit except the first, which has two because of the higher occupancy. Each unit consists of copper louver and screen air intake, filters, preheating and heating coils, spray chamber and blower. Valves and dampers actuated by compressed air control conditions on each floor; relative humidity is maintained in summer by dewpoint control, and in winter by hygrostats operating solenoid valves.

The ducts, for which some 70,000 sq ft of sheet metal were required, were enclosed and plastered and painted to give the appearance of beams. Openings are small and inconspicuous. On the street floor, ducts run down one side and along the ends, and on the other floors along the center.

The 3,600 gpm condenser water cooling tower on the roof is 35 ft high, 60 ft long and 30 ft wide.

Approximately 1,500 hp of installed motor capacity is required for the system. There are two 400 hp and one 250 hp variable speed motors for the three new compressors; one 7½ hp, three 10 hp, seven 15 hp, two 1½ hp, and one 3 hp variable speed motors for the fans; three 40 hp and three 50 hp constant speed motors for the chilled water pumps; and four 20 hp constant speed motors for the cooling tower. Motors are rated at 208 volts, 3 phase, 60 cycles; motor circuits are controlled from a separate cubicle type switchboard in the engine room.

Although the building has its own fuel oil heating plant and power plant, the increased load requires purchase of Edison power. Three 600 kw transformers step down the street current from 13,800 volts to 208 volts. Some 16,000 ft of electrical conduit was required for the 50,000 ft of wiring necessary.

The illustrations of the piping give an idea of the extent and complexity of this part of the job. The 14,000 linear ft of piping (14, 12, 10, 8, 6, 5, 4, 3½, 3, 2½, 2, 1½, 1¼, 1, and ¾ in. pipe sizes) aggregated 35,000 linear inches of welding, including the welding of copper alloy pipe, brass pipe, pipe angles, lugs, etc. Gas consumption for welding totalled 16,000 cu ft of oxygen and 14,500 cu ft of acetylene, and the welding rod consumption was between 500 and 600 lb.

*Planning Engineer, Wm. Filene's Sons Company, Boston, Mass.

Heating and Ventilation Methods *of Early American Builders* Show Skill and Ingenuity

FEW Americans today realize the extent of advancement in building and culture attained by the aboriginal Americans of our southwest, who began building stone houses as early as 650 A. D.; by 1000 A. D. they were living in the best homes in the world.

Many of these early houses and apartments are still in a fair state of preservation, and I recently spent some time in the Mesa Verde National Park and the Aztec Ruin National Monument getting first-hand data about them. So far as I know these buildings are the only prehistoric structures having heating and ventilating systems.

The years from about 1050 A. D. to 1250 A. D. represent the height of this remarkable social order. The illustrations give some conception of the structural details of their buildings. The masonry compares well with modern masonry but they had only clay mixed with water for mortar. In some instances they plastered the inside of their rooms with clay and decorated the walls with paintings.

Some of these apartment buildings housed several hundred families. They were built of stone with small logs or poles for roof timbers. These were cross-covered with smaller sticks or split poles and plastered over very carefully with adobe mud. Often the building was carried up three and four stories in which case the floors between stories were of the same roof construction. The masonry walls were, in some cases, 24 to 30 inches thick, affording excellent protection against enemies and the elements.

*Mechanical and Industrial Engineer, Denver, Colo.

The territory occupied by this race of people is quite warm in summer and cold in winter and they consequently recognized and solved the problem of heating and ventilation. Throughout an entire building each sleeping room was provided with ventilation openings. These were not for the admission of light but strictly for air circulation. The only means of heating was an open fire inside the rooms; the ventilator openings drew off the smoke. These builders were smart enough to locate their ventilators near the room ceilings so the air would circulate by the thermo-syphon principle. By this arrangement they had a clear, smokeless stratum of air to breathe.

Provision was not made for a fire in every room. Fireplaces were located only in a few rooms but because there were no dead air spaces in the buildings the warmed air circulated throughout the entire structure. And there was one of the first central heating systems.

But the special ceremonial and club rooms for the men had even more highly developed "air conditioning" than did the general sleeping quarters. These rooms, called *kivas* (key-vah), were built for maximum comfort be-

Fig. 1—General view of Cliff Palace, Mesa Verde National Park, Colorado, built about 1073 A. D., best example of prehistoric pueblo building we have. In the foreground can be seen a row of kivas (with roofs off) showing a type of masonry that carried the circular wall above the tops of the pilasters to the ground level. The ventilator shafts can be seen and, through the broken wall in the nearest kiva, a view of a deflector is had. The square buildings are sleeping rooms. The small rectangular openings are the ventilators and the larger openings doors. Most of the doors are inter-room connections. Many of the rooms are now gone leaving some of the doors on outside walls

By **Carleton W. Campbell***

cause the men spent long hours and days there when not at work in the fields. They were usually built mostly below the level of the ground; in some locations, such as in large caverns where a solid rock floor was encountered, they were sometimes built up of heavy masonry and surrounded by earth. This provided for cool air in hot weather and prevented heat losses in winter.

Most kivas were circular, from 12 to 75 ft in diameter, and were 10 to 20 ft from floor to roof; usually they were separate from the sleeping rooms although in some cases doors connected through to the living rooms. Each kiva was provided with a square or rectangular flue built outside of the main circular wall and extending from the roof level to the floor level. This was not a smoke exit, but the fresh air duct. At the floor level the duct turned at right angles to open through into the kiva room. About 2 or 3 ft from this opening a wall (usually of masonry) was built up about 4 ft long and 3 ft high and directly in alignment with the incoming fresh air. This served as a deflector, dividing the air stream and sending it in opposite directions around the periphery of the room. In the center of every kiva was the fire place. The deflector wall thus stood between the fire and the cold air duct preventing direct discharge of the air into the fire. The cold air, having a circular movement around the room, was drawn in toward the fire tangentially forming a helical column of rising air in the center of the room. The smoke exit was a hole or shallow flue in the center of the roof.

Fig. 2—Looking down in a kiva built partially in a natural cavern. This shows the fire place, the air deflector (in this example made of small timbers and masonry), and the top and lower extremity of the cold air duct. The roof has been taken off. This dates from the eleventh century

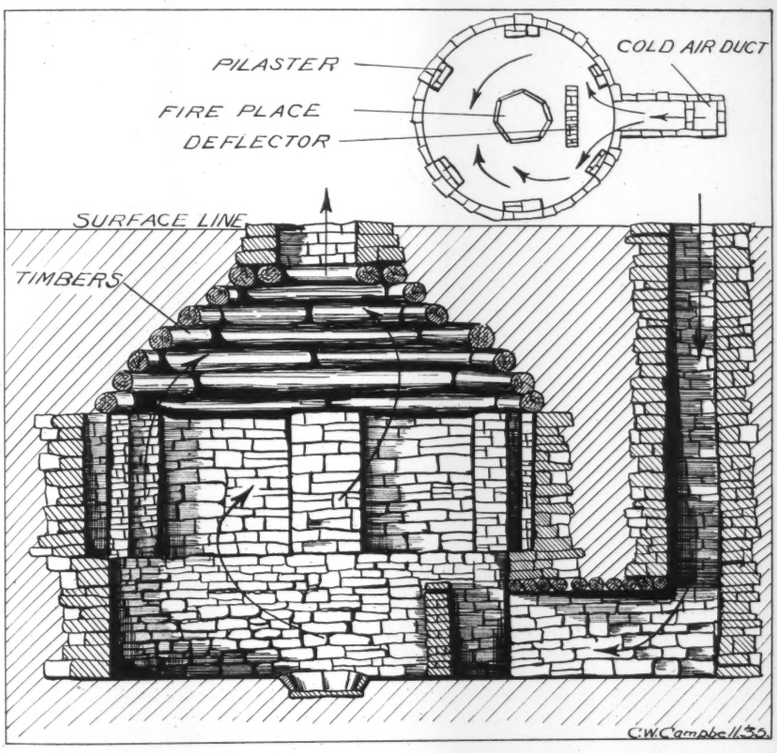


Fig. 3—Drawing, by the writer, of a kiva built before the highest achievement in building was reached, showing typical ventilating system. This example is about 12 ft in diameter; later they were much larger and plastered inside. This one was built about 1000 years ago

The men sat around the fire on the floor in a gentle current of fresh smokeless air. In cold weather a good lively fire warmed the room by direct radiation and in summer a very small fire was sufficient to set up circulation. The incoming air was cooled by passing down through the cold air duct surrounded by cool masonry and earth. In kivas that still have the roof intact, these ventilating systems work perfectly to-day.

There is definite evidence that these ancient builders understood the principle of cooling water by placing it in porous earthenware so that evaporation from the moist exterior took place. It is believed that certain of their water jugs and cooking utensils were made with a corrugated exterior to increase the radiating surface for heat exchange for both cooling and heating the contents. Many fine examples of this corrugated earthenware can be inspected in the government museums at the Mesa Verde and Aztec ruins.

Certain types of water jugs are always found in the kivas. It is logical to believe they may have been placed in the circulating air stream for general cooling purposes. Their ornamental ceramic work is not corrugated but is smooth and polished.

New Sewage Treatment Plant Involves

Big Piping Job

By **A. F. Bowers***

THE new addition to the Milwaukee (Wis.) Sewage Treatment plant on Jones Island, soon to be completed, involves a piping job amounting to well over $200,000. This plant is the world's pioneer activated sludge plant and has done extensive work in forwarding the proper handling and treatment of sewage since it went into operation in June, 1925.

The Treating Process

Before describing the piping services in connection with the process, it will be well to consider briefly the handling and treating of raw sewage, which consists mainly in the eradication of about 95 per cent of the suspended solids and 98 per cent of the bacteria.

The sewage is carried to the disposal plant on the island by a system of intercepting sewers terminating in four siphons under the harbor entrance, 60 ft below water level, with a capacity of 317 million gallons daily. All the sewage passes first through coarse bar screens, spaced 3 in., apart, which remove very large particles consisting of rags, sticks, etc. The coarsely screened sewage then flows through eight grit chambers where the velocity is reduced from 10 to 1 ft per sec to settle out the heavier material such as sand, cinders, fine gravel, and clay. It then passes through the fine screens, consisting of eight revolving bronze drums, equipped with bristle brushes to remove hair, matches, fruit peelings, grain, etc. The screened sewage then goes into a mixing chamber where activated sludge is mixed in the ratio of 25 per cent to the volume of raw incoming sewage.

The bacteria structure of raw sewage consists principally of two forms—aerobic and anaerobic bacteria. The former must be supplied with air to keep them alive and active, and in this state they annihilate the anaerobic bacteria.

From the mixed liquor chamber the raw sewage flows to rectangular aeration tanks equipped with an extensive system of piping connected to container blocks placed at the bottom of the tanks. These container blocks are made of concrete. They are formed with an aluminum pipe tap cast into one end and are hollow, with the upper faces composed of square carborundum porous blocks through which air at 10 lb pressure is forced into the sewage, giving the aerobic bacteria life and indirectly annihilating the anaerobic bacteria. The flow is so regulated that it takes 6 hours for the mixed liquor to travel through the aeration tanks, during which time about 1½ cu ft of air has been supplied per gallon of raw sewage.

From the aeration tanks the mixed liquor flows into the sedimentation tanks. The mixed liquor enters these tanks continuously and the sludge settles to the bottom, carrying with it practically all of the finely divided material originally present in the sewage. Practically pure water overflows from these tanks and into the lake while the settled sludge is continuously removed from the bottom.

The sludge drawn from the bottom of the sedimentation tanks, containing about 1½ per cent of solid matters, flows to a sludge well. From there about 90 per cent of the sludge is pumped to the mixing chamber, where it is mixed with the incoming raw sewage; the balance goes to the filters and dryers, screens and grinders, and is sold for fertilizer.

The sludge carried to the mixing chamber is called activated sludge because of the active properties of the aerobic bacteria and is mixed with the raw sewage to accelerate the destruction of the anaerobic bacteria.

Piping is Important Part of Plant

Air is supplied the aerobic bacteria by four turboblowers with a capacity of 30,000 cfm each and two blowers of 50,000 cfm each against 10 lb back pressure. This air is passed first through oil and paper filters which remove the dust and soot to prevent clogging of the diffuser plates. The air is then carried to the container blocks in the channels and aeration tanks through cast iron and genuine wrought iron pipes, galvanized.

In the original plant, approximately 2,533,500 lb of Class "A" cast iron pipe and 916,500 lb of Class "A" cast iron fittings are used for the main air lines. This pipe is all coated with a special tar coating to eliminate deterioration due to the alkaline condition of the raw sewage. The connections between the cast iron mains and container blocks comprise 53,000 ft of standard genuine wrought iron pipe, galvanized, with approximately 23,300 malleable iron galvanized fittings. The pipe, fittings, and valves for the activated sludge which is drawn off for fertilizer purposes is all Class "A" cast iron, rubber lined because ferric chloride is added to the sludge before manufacturing it into fertilizer. This sludge is known as acidified activated sludge. There is approximately 54,300 lb of such pipe.

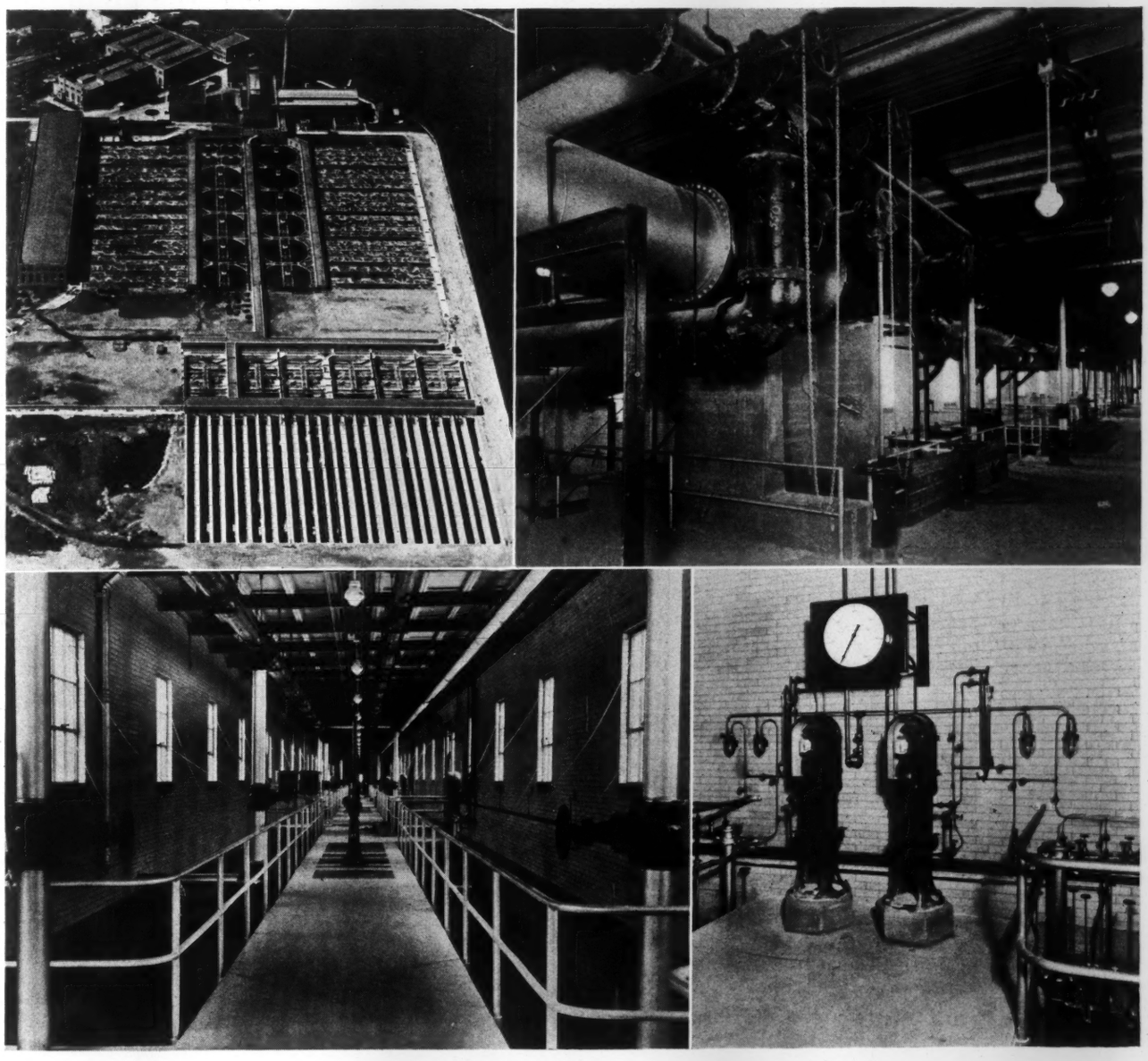
The new addition has 276,500 lb of welded steel pipe and 28,000 lb of welded steel fittings for the mains 24 in. and above; interior of pipe and fittings is stainless steel clad. The mains from 6 to 20 in. in diameter consist of 975,300 lb of Class "A" cast iron pipe and 357,200 lb of Class "A" cast iron fittings with a special tar coating.

There is approximately 20,660 ft of standard genuine wrought iron pipe, galvanized, and 8,980 malleable iron galvanized fittings used in the connections from the main air lines to the container blocks.

The total steel and cast iron pipe and fittings in connection with the air piping, amounts to 5,087,000 lb, and there is approximately 73,660 ft of wrought iron pipe and 32,280 malleable iron fittings for this purpose.

All cast iron pipe and fittings below the sludge is bell and spigot using a braided hemp packing and 2½ in.

*Industrial Heating & Engineering Co., Contractors and Engineers, Milwaukee, Wis.



New addition to Milwaukee sewage treatment plant and some of the piping. The upper left view shows the new portion of the plant; at the lower right, the effluent meters for metering outflow from entire plant are seen

depth of lead calking; that above the sludge is flanged. All wrought iron pipe and fittings below the sludge are screwed and above, flanged.

The cast iron pipe was thoroughly cleaned before installation and the wrought iron wiped clean of all grit and then pickled in a solution for a period of 40 minutes to eliminate any grease or oil.

Expansion and contraction in the mains is taken care of with special stainless steel bellows expansion joints.

Metering the Air

The air supplied to the sewage is metered at each aeration tank and at various sections in the channels; the air meter registers record the amount of air supplied each tank, its pressure, and its temperature.

The effluent or outgoing water is metered. As there is a definite relationship between the velocity and pressure of fluids when flowing through converged and diverged tubes, two large concrete venturi tubes with metering devices are used. Each tube takes the shape of two truncated cones joined in their smallest diameters by a short throat piece. The pressure at the upstream or large portion of the tube is less than that at the throat. These pressures are conveyed by means of pads, located in the upstream and throat portions of the tubes, through copper piping to piezometer pipes and thence to meters and totalizing devices where the pressure is converted by gear mechanism into millions of gallons per day.

The amount of sewage supplied to each aeration tank and to various channels is similarly metered, with the exception that cast iron in place of concrete venturi tubes are used.

The piping in connection with the meters is nominal copper water tubing. The fittings in the sewage are standard screwed brass and those above, standard sweat. Approximately 3,100 ft of copper tubing and 2,100 brass fittings are used.

PRACTICAL HEATING

By **Harold J. Taylor***

HEATING SERVICE WATER WITH CAST IRON BOILER

TO select a cast iron water heater of proper capacity for a job, refer to boiler manufacturer's catalogs or data book; it will be found that heaters are usually listed as being capable of heating so many gallons of water so many degrees rise per hour. I would suggest that a heater be selected that will add from 25 to 45 deg per hr, dependent upon demand of the job. The installation of an automatic damper regulator is very necessary on an installation of this kind, both from the standpoint of economical operation and boiler protection.

If the size of heater required for a job is greater than the capacity of a hot water supply heater, and it is desired to use a regular heating boiler, proceed as follows:

Let us assume that we have 550 gal of water to heat on a 45 deg rise per hr and we want a boiler of fair size to handle the job.

We first reduce gallons to pounds of water:

550 gal of water times 8.33 lb of water per gal equals 4581 lb.

Since it requires 1 Btu to raise 1 lb of water 1F, it will require 4581 Btu's to raise this quantity of water 1 F per hr.

If we must raise the temperature 45 deg per hr, then it will take 45x4581, or 206,145 Btu's.

Since heating boilers are rated on the sq ft of radiation basis, we must convert our total of 206,145 Btu's into sq ft of radiation.

We know that 1 sq ft of cast iron radiation under "standard conditions" will give off 150 Btu's per hr (water). Therefore, if we divide our total of 206,145 Btu's by 150 our answer will be the sq ft of boiler capacity required.

206,145 divided by 150 equals 1374 sq ft. In this case we would select a boiler size based on "maximum output" and not on sq ft of E. D. R. (equivalent direct radiation) load.

Boiler Ratings

To make this statement clearer in regard to selecting boiler size, I might add that boiler manufacturers usually list the ratings of their boilers as follows:

Maximum output	1050 sq ft
Recommended load, sq ft E.D.R.	750 sq ft
Rating, sq ft	7600 sq ft
Recommended actual connected radiation load	4180 sq ft

It is seen by the above that boilers are rated in two distinct ways. For heating of radiation we use the smaller rating, for heating domestic hot water, we use the larger rating. Due to the fact that a boiler used for heating domestic hot water is under continuous fire, we do not have to allow for pick-up as in the case of radiation when it is allowed to cool off and the demand on the boiler to reheat this radiation is much greater.

If we were to select a *steam* boiler for the above job, we would divide 206,145 Btu by 240 as 1 sq ft of cast iron steam radiation under "standard conditions" will give off 240 Btu per hr.

206,145 divided by 240 equals 859 sq ft. In this case we would select a boiler size based on "maximum output" and not on sq ft of E. D. R. (equivalent direct radiation) load.

Cast iron heating boilers are usually suitable for 30 lb working pressure; however, some manufacturers furnish and guarantee cast iron boilers for working pressures up to 100 lb.

Most heaters designed especially for heating water are tested for 100 lb working pressure.

A hot water boiler for 30 lb working pressure should not be used in buildings of four stories or more in height as sufficient water and pressure will not be available at the top floor.

Where a 30 lb pressure boiler is installed and the cold water supply to boiler exceeds this pressure, a strainer, pressure reducing valve (set at not over 28 lb), a relief valve (in cold water line) set at 30 lb, and a pressure gauge, not of the retard type, should be used. In some cities, a code will govern this type of installation.

When using a high test heater on a job, it is advisable to set the relief valve at a pressure only as high as required to furnish water of necessary pressure and volume at the top floor fixtures.

*Contracting Engineer, Detroit, Mich.

Stream-lined observation end of the "Abraham Lincoln," new light weight, high speed train of the Baltimore and Ohio-Alton, equipped throughout with an advanced type of air conditioning which eliminates the usual side-wall radiators by performing all heating in a central bank of coils through which air is forced. Cooling is similarly accomplished by another set of coils.

Although incorporating many refinements, this air conditioning system is basically similar to that installed in the B. & O.'s "Columbian" which went into service in 1931 between Washington and New York as the first completely air conditioned train in the world.

"On the Job" in Piping Maintenance

By W. H. Wilson*

ON THE job means to be up and doing, not only in observing and inspecting, but seeing that necessary repairs, alterations and methods of operating are performed promptly and effectively. The following are ordinary occurrences that come to the attention of the maintenance force.

A department of a large plant was required to work overtime for several nights. The equipment in operation used a certain amount of compressed air. As a matter of economy, instructions were given to use a small size electric driven air compressor to supply this one department during the night period, the shut-off valve on the main air supply line being closed, instead of operating the large steam driven air compressor. The small portable compressor was accordingly put in operation, but failed to maintain sufficient air pressure to meet requirements, although rated capacity was ample.

Inspection of the air piping in the department showed several controlling valves of the air operated devices leaking. These were promptly repaired and the compressor easily maintained the necessary pressure, operating intermittently according to load conditions. These air valves had been leaking for some time, but no particular attention was paid to them as the compressed air was furnished by the shop lines, a never failing and constant supply. Conditions would probably have continued in this manner for some time if the overtime work had not put someone on the job.

A large steel fabricating plant using many air operated tools, such as drills, reamers, grinders, riveters and oil furnaces, with flexible hose for the air supply connections, was confronted with the problem of reducing a large air loss caused by leakage through the tools and hose connections. Many of the tools leaked badly and the hose connections, many times, were improperly made. Repairs to tools and equipment were neglected. A department order was issued directing supervisors to see that all hose connections to air operated tools, furnaces and overhead air hoists were shut off during the noon lunch period and at quitting time. Previous to this, noise from the escaping air could be heard when work ceased, as the air compressors were in continuous operation for other operating departments. A quiet noon hour was the result when the air connections were shut off and the air saving was evident. However, "on the job" in this case would mean that the air operated equipment should be repaired and the hose connections put in proper condition, so that the air leakage would not continue during the eight-hour working period. The saving in the air supply furnished during the entire working period could be added to the amount of air saved by shutting off the air supply during the noon period.

Location of Steam Traps

"On the job" can be applied to the location of steam and other appliances. A steam trap should be placed where it is readily accessible and can be inspected periodically, especially when it receives the condensation from large steam mains and separators. Locating the trap in out-of-the-way places, under stairways, in poorly lighted tunnels and basements should be avoided. A trap that is not ordinarily visible or readily accessible will not get the attention it requires. A steam trap failing to operate automatically is likely to cause trouble and damage to pipe lines and other equipment. A steam trap leaking badly, "blowing through," may protect the steam main from water hammer, but this loss of steam is expensive protection and unwarranted waste. A check-up of the traps in many plants will show that most of those in out-of-the-way places need attention and repairs.

Careful attention should be given when making proposals for alterations, additions and changes to plant equipment. Some years ago a large sign located on the roof of a plant was illuminated by gas. The proposition for changing to electric lights was considered. Figures were prepared showing comparative costs. The gas lights were burning steadily and the gas consumption, on 24 hours daily use, was estimated with reasonable accuracy. The statement, according to the figures, was in favor of the electric lights by a large margin. Before the figures were submitted to the plant management for approval, someone happened to investigate and discovered that the gas supply was on an individual meter and the gas lighting controlled by a time clock that automatically reduced the amount of gas enough to keep the burners lighted during the daylight hours and increased to the normal amount at night to furnish the proper illumination. This caused a new set of figures to be prepared which differed perceptibly with the former estimate. The change of lighting was approved and carried out. By looking over the proposition carefully beforehand, the sponsors were relieved of what might have been an embarrassing situation, if any one should have compared the original estimate of the gas consumption with the gas bill as shown by the readings on the individual gas meter for the sign.

"On the job" may be considered from different standpoints. The supervisor of a certain department in an industrial plant was always ready to mention cases where his workmen were immediately on the job in case of trouble and how delays were reduced to a minimum by the record breaking speed with which service was restored. A careful check-up would undoubtedly reveal that much of this hurry-up work could have been avoided by a well-managed and regulated system of inspection and attention to repair work before a delay or shut-down was necessary. Many short notice emergency jobs can be prevented by tightening bolts in flanged joints at the first sign of leakage, instead of waiting until the gasket blows out. Pipe hangers and supports, out of place and adjustment, or broken down, can cause trouble unless promptly replaced. Bad leaks at expansion joints can be prevented by tightening the packing box bolts at the first sign of leakage.

*Member of Board of Consulting and Contributing Editors.

Removing Moisture from Compressed Air

By A. W. Loomis*

THE practical value of removing moisture from compressed air has been proved beyond doubt in thousands of cases. Nevertheless there are still many plants using compressed air where no provisions are made for removing the moisture from it. In most of these installations the savings in lower repair and maintenance costs on air operated equipment will pay for the installation of adequate moisture removal apparatus many times over.

The most harmful effects of water in compressed air are: The washing away of lubrication in air-operated tools, thereby causing excess wear, sluggish operation and high maintenance charges; freezing of air-operated tools due to the low temperatures developed when air expands; production of water hammer in pipe lines; freezing of water in pipe lines during cold weather; and reduction in carrying capacity of the pipe lines.

Location of Intake

Before going into the methods of removing moisture from air, it may be well to point out that very often the air compressor intake is so located that excessively moist air is being taken into the machine. If the air compressor intake is located in a steam- or vapor-filled room as is often the case around laundries and in many types of chemical plants, a great deal of moisture is constantly being taken into the unit. This condition can be greatly improved at very little expense by moving the air intake to a drier locality. Usually it is simply a case of extending the intake pipe to the outside of the building. Suitable protection from the weather must of course be provided for any outside intake. A further advantage of this location of the intake is that cooler air is usually obtained. This in effect increases the capacity of the compressor as it prevents the loss of volume which occurs if the temperature of the air at the point of use is lower than the temperature at the air intake.

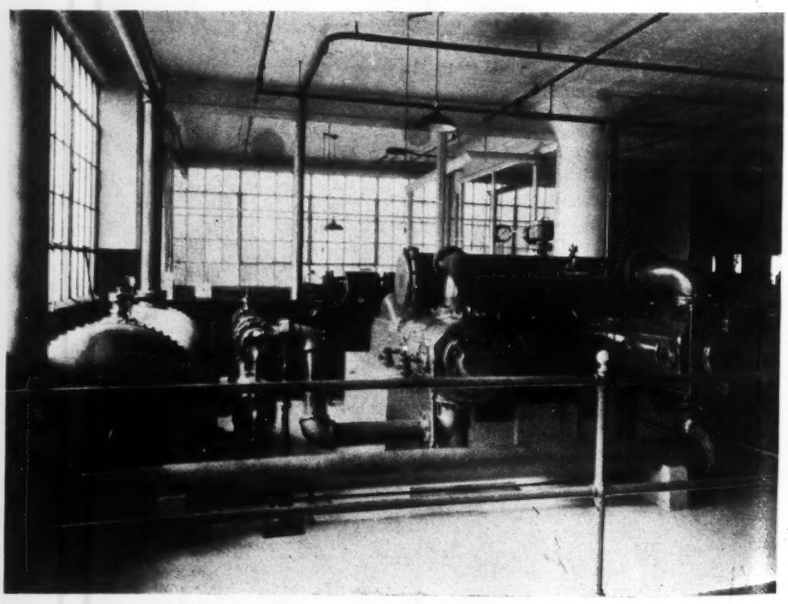
Proper placing of the air intake is an important point, but it alone will not take care of the moisture problem. Compressed air cannot hold as much moisture as the same air before compression and consequently a great deal of moisture condenses and collects in various parts of the compressed air system.

Aftercoolers and Moisture Separators

Two effective means for removing this moisture are by means of air aftercoolers and pipe line moisture separators. Which method should be used will depend on the size and nature of the installation. In some cases both methods are used.

In most instances an aftercooler is most effective because the water is removed before it has had a chance to enter the distribution lines. An aftercooler reduces the air temperature to a point where most of the moisture and oil condense and can be removed. This is accomplished by bringing the air into contact with pipes within the cooler through which cold water is constantly circulated. This not only eliminates the difficulties which moisture causes at points where air is used, but also insures more effective distribution. The air leaves the aftercooler at a uniform and relatively low temperature

*Ingersoll-Rand Co., Phillipsburg, N. J.



610 cfm compressor, aftercooler and air receiver in manufacturing plant

and prevents air leaks caused by constant expansion and contraction of the pipe lines.

Aftercoolers are available to handle any volume of air from about 100 cfm of free air (12.8 cfm of compressed air at 100 lb pressure) to 11,000 cfm. There are several types designed to fit most any space that may be available for their installation. One type replaces a section of the distribution piping and takes up little more room than the pipe itself.

With efficient aftercoolers, sufficient moisture is removed to satisfy most applications of air and no further care need be exercised. Where the air is used for such purposes as paint spraying, enameling, food agitation, and the like, further drying of the air can be effected by passing it through special moisture separators immediately before it is used. These remove whatever moisture may condense due to further cooling of the air in the pipes after it leaves the aftercooler.

For installations where less than 100 cfm of free air is used, and in some cases for greater volumes of air, some type of moisture separator is the usual means of removing the water from pipe lines. Such separators are inexpensive and are available in many sizes and types. These separators consist of a reservoir for collecting moisture and are usually provided with baffles or otherwise arranged in order to secure as effective moisture removal as possible. Some types must be drained by hand as moisture accumulates in the reservoir. This type is provided with a suitable drain valve for the purpose. Other types are self-draining, the drain valve being operated by a float within the reservoir. Some such moisture separators also incorporate an air filter in the unit. Practically all types fit into a section of the pipe line and as the weight is not great they require no more support than any other portion of the line.

In a plant using 100 cfm of air during an 8 hr day as much as 7½ gal of water will condense in the aftercooler or in the pipe lines in the event that no aftercooler is used.

It can readily be seen that this amount of water will cause considerable trouble in the operation of pneumatic tools, hoists, air operated presses, paint sprays and the like. Operation of a compressed air plant without adequate means for moisture removal is far more costly than the small outlay necessary to provide aftercoolers or moisture separators.

Variations in Air Conditioning Bids

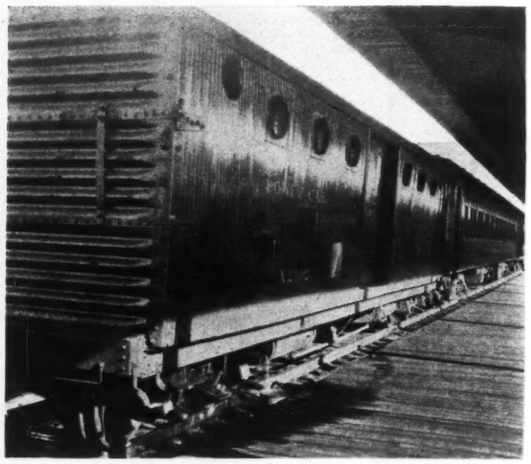
IN a paper presented at the annual convention of the *Heating, Piping and Air Conditioning Contractors National Association* entitled "What's Involved in the Sale of Air Conditioning," J. J. Nance, manager, air conditioning division, Frigidaire Corp., touched upon variations in air conditioning bids, pointing out that the engineering of the job is the largest single factor in determining the price, because the specifications of design determine the equipment requirements.

Several examples were cited by Mr. Nance. One price for a theater installation was $11,000 and another price $7,000; the difference was found to be in the temperature differential, one set of specifications guaranteeing a 15 deg differential and the other a 5 deg differential. A difference in 2 tons capacity would be caused by using two instead of three air changes on a 10 to 15 ton job, according to Mr. Nance. Two designs for a specific job provided 7,000 cfm of air to be circulated in one case and 5,500 cfm in the other; this caused a difference of 21 per cent in the cost of duct work, he said.

Another source of variation in bids is due to the occupancy figure used in the design, a matter which comes up on almost every job of a public gathering place nature—tap rooms, dining rooms, restaurants, grill rooms, etc. Either the present occupancy or the probable greater occupancy due to the installation of air conditioning can be used, the cheapest time to take care of the increase being at the time of the original installation. Assuming one bid based on 100 occupancy and another on 140, the latter is at a disadvantage unless the two designs are understood by the purchaser, as every additional occupant added to that job means anywhere from $20 to $30 increase in the cost of the job.

Moscow's Red Square, showing the black and red marble tomb of Lenin in which an air conditioning system is being installed to permit the tomb to be open all day instead of but an hour each day

Field's "Merchandise Express" Brings Goods, Comfort to Buyers



The power car, which carries three gasoline engine driven motor generators for supplying power for air conditioning the other ten cars of Marshall Field & Company's "Merchandise Express"

MARSHALL Field & Company's "Merchandise Express," a wholesale house on wheels, provides almost all the facilities of the modern retail store to serve its customers, including air conditioning. Purpose of the train is to bring the goods to the buyers; the maiden trip covered nineteen southern cities, and present plans will keep the train in operation until late fall. It is expected that when the last scheduled journey is finished, further plans will be made to continue its operation.

The "Merchandise Express" comprises eleven cars, ten of which are air conditioned, the eleventh being the power car. It is devoted to the promotion and sale of over 500 different lines of goods, and is equipped with complete office facilities, including teletypewriter and telephone service which is connected at each stopping point. Sleeping and dining facilities are provided for the crew of some 50 persons.

Unlike the ordinary train, the "Merchandise Express" travels only at night and is generally open to visiting buyers and merchants during the day—8 a. m. to midnight. It was therefore necessary to supply power for air conditioning from the special power car by means of three gasoline engine driven motor generators.

South African Gold Mines Adopt Air Conditioning

COMPLETION of the initial air conditioning plant at the Rand Gold Mines in South Africa is to be announced shortly, according to a report from American Commercial Attache Samuel H. Day of Johannesburg to the Machinery Division of the Department of Commerce. This installation is at a mine which has the deepest underground workings of any in the world. The plant is located on the surface, the conditioned air being delivered into the regular mine ventilating system. The extreme depth of the workings in this area has made necessary the adoption of means to improve temperature, humidity, and dust conditions. Men have found it impossible to work in the lower levels except for short periods of time. The air cooling system should eliminate the incidence of heat stroke and also should reduce the hazard of accident among the workers, as improvements in atmospheric conditions will make them more alert than is the case when excessive heat and humidity obtain. Again, the liability of workers to cuts and abrasions should be greatly lessened, as under the improved conditions they would no longer have a tendency to discard clothing and leave their skin unprotected. While workers will have to travel a part of the distance in the shaft in very cold air, they will be supplied with warm clothing, as is now done during the winter months.

The net effect of the installation of this plant should be that temperature conditions will be set back in the most active workings of the mine, which are at the 7,500 ft level, to those formerly prevailing at 6,000 ft.

The apparent success of this installation has led to others. The East Rand Proprietary Mine is installing a 150,000 cfm sub-surface plant to be located at the 6,500 ft level of the Hercules shaft. It consists of two plants, each complete, each unit having a four-cylinder 12½ in. diameter by 10 in. stroke reciprocating compressor having a 250 hp synchronous motor directly mounted on the crankshaft.

The Crown Mines are also installing a sub-surface plant.

The importance of cooler working conditions at the lower depths now found on the Rand was shown as a monetary factor by one of the mine managers at a recent meeting of the association of mine managers. He presented a rough calculation as follows, referring to the whole reef basin:

"Assuming a modest percentage of payability of the ore, for every 1 F increase in temperature that we can work to, or, put in another way, for every additional 200 ft in depth, it is estimated that there is recoverable gold revenue to the value of no less than £20,000,000 which figure is therefore the value to the country of a saving of 1 F in mine air temperature."

Heating · Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

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Heat Absorbing Glass Windows

By **W. W. Shaver*** ***(NON-MEMBER)***

Corning, N. Y.

IT is a well recognized fact in the air conditioning field that the sunlight energy coming directly through the windows of a home or office may constitute a very considerable percentage of the total cooling load on the refrigeration equipment controlling the room temperature and general comfort of the occupants, particularly where the thermal insulation of the sidewalls has reduced the heat conduction load to a minimum. On this account, any effective means of reducing this solar energy load without materially interfering with the original purpose of the windows may be of real importance in broadening the application of air conditioning through a material reduction in the peak load and operating cost of the equipment. Special heat-absorbing clear glasses having high light transmission with very little color have been suggested for this purpose and discussed in a number of recent papers [1, 2, 3]. In connection with the use of these glasses as window glasses, questions have arisen regarding the potential economies in the operation of air conditioning equipment; the effect of such windows on the general comfort of the occupants of the room or dwelling; their effect on the fuel bill in winter in case of a permanent installation; and the behavior of the glass under general service conditions. In order to provide some information on these points, a series of tests was carried out during the greater part of 1934, the results of which are summarized in this paper.

Before describing the experiments in detail it may be well to give a brief outline of the process by which heat-absorbing glass is effective in preventing a considerable portion of the solar energy from passing through the window. Sunlight falling on any glass window is partly reflected, partly absorbed, and the remainder transmitted directly into the room. The amount of reflected energy varies with the angle of incidence, being about 8 per cent for clear glass at normal incidence, and insofar as the interior of the building is concerned this reflected energy is effectively lost. The energy that is absorbed by the window heats the glass, which in turn dissipates this heat by conduction, convection, and radiation in all directions, the temperature of the glass meanwhile rising until the heat lost by this process is equal to that absorbed. Thus, with single windows, in quiet air, approximately one-half of the energy absorbed by the glass finally enters the room through this secondary reradiation process. Now ordinary window glass absorbs only about 4 per cent of the total energy in sunlight, transmitting 92 per cent of the visible light, which constitutes 44 per cent of the sun's total energy. (See Table 1.) Hence the amount of energy entering the room by the reradiation process is very small in comparison with the direct sunlight transmitted through the glass, and likewise there is very little heating of the glass.

Table 1—Characteristics of Glass Used in Tests

Glass	Thickness	Visible Light Transmission	Total Solar Energy Transmission	Total Solar Energy Reflected
Borosilicate Heat-resisting Heat-absorbing plate	3 mm	76%	42%	5%
Ordinary window double strength	3 mm	92%	88%	8%

In the case of special heat-absorbing glass the selective absorption effect is very much enhanced, with a total absorption of about 53 per cent of the total energy in sunlight and a visible light transmission of 76 per cent. With this marked increase in absorption, the reradiation effect becomes an important factor in transmitting energy into the room; so that while a very desirable heat screening effect is obtained with a single window of heat-absorbing glass, due to the fact that the glass dissipates heat outwards as well as inwards, much better results should be obtained through the use of double windows, with ordinary glass in the inner sash, special heat-absorbing glass in the outside sash, and means provided for removing the heat absorbed by the outer sash glass as rapidly as possible. Another consequence of the high percentage of energy absorption in the heat-absorbing glass is that the glass becomes very hot when exposed to intense sunlight so that it may be subjected to very severe thermal stresses, as for example when shadows cover part of the window. Hence the thermal resistance of heat-absorbing glass must also be considered.

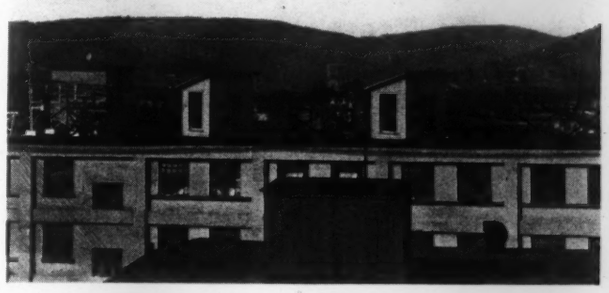

Fig. 1—Test houses used in heat-absorbing glass experiments

On account of the continual variation in the energy in sunlight at the earth's surface, duplicate test equipment must be available in order to make a direct comparison of the two types of glazing. Accordingly, two test houses, shown in Fig 1, of identical design and construction were built on the roof of a 4-story factory building at Corning, N. Y., in a location free from objectionable shadows and where atmospheric condi-

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[1] Hobbie, *Transactions, Illuminating Engineering Society*, Vol. 28, 1933, pp. 658-664.

[2] Estey and Miller, *Transactions, Illuminating Engineering Society*, Vol. 30, No. 5, 1935, pp. 403-410.

[3] Shaver, *Refrigerating Engineering*, Vol. 26, No. 3, 1933, pp. 133-136.

Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Toronto, Ont., Can., June 1935.

tions were satisfactory. Each house was of wood frame construction with a single insulated and tightly fitting door and two windows which faced the southeast and southwest. The interior dimensions of the houses were 8x8x8 ft and the window sash were each glazed with 16 lights of 12x18 in. glass. Two layers of ½ in. fiber insulating board were used to insulate the sidewalls and three layers of the same insulation protected the ceiling. The walls and ceiling of fiber insulating board were sized with a heavy coating of shellac to prevent the absorption of moisture.

Each house was cooled by circulating ice water continuously from a central outside storage tank through the cooling coil of a room cooler whose fan was operated by means of a thermostatic relay. The rise in temperature in the water flowing through the cooling coil was measured by a series of 10 differential copper-constantan thermocouples, one set of junctions being placed in the water stream at the point of entry and the other set in the stream at the point of exit. This temperature difference was recorded on a potentiometer recorder. The flow of water through each cooler was measured with a specially calibrated water meter. Thus from the record of the rise in temperature of the water stream and the metered flow of the water, the amount of heat withdrawn in any given time could be determined. In order to keep the temperature of the room as uniform as possible and to insure good thermostatic control, a 10-in. electric fan was mounted in one corner near the ceiling and operated continuously with its blast directed downward across the bimetallic element of the thermostat. The entire electric power used in operating the fans and recorders was measured with an electric meter in each house.

The characteristics of the borosilicate heat-resisting, heat-absorbing glass and the ordinary window glass used in the tests have been given in Table 1. The heat-absorbing glass was 3 mm polished plate of a slightly bluish-green color, but so light in tint that it could scarcely be noticed by an observer standing inside the test house. The ordinary window glass was of double strength drawn sheet.

Tests were made on every suitable day from July 16 to October 10, 1934. During this period the weather was not very satisfactory for the experiments, and in the entire period only two days could be classified as ideal. The first set of tests was made with double windows, one house having ordinary glass in both inner and outer sash and the other having ordinary glass in the inner sash and heat-absorbing glass in the outer sash. All the outside sash were equipped with slots at the top and bottom which permitted reasonably free circulation of air between the windows. Check tests were made by interchanging the window combinations on the two houses. The results of these tests are given in Table 2.

In order to determine the effect of the slots on the outer sash and the resulting ventilation of the space between the windows, one run was made in which the slots in the outer sash of No. 1 house with the combination of ordinary and heat-absorbing glass were alternately opened and closed at the end of every hour, while the slots in the outer sash of No. 2 house with the ordinary glass windows were left open during the entire period. The results are given in Table 3 and show rather definitely the effect of ventilation between the sash.

The power used in operating the test equipment, as determined from the electric meter readings, was so nearly alike in the two houses that no correction has been made for it. This would be expected as the equipment in the two houses was identical and most of the power load was continuous during the tests. The actual power used per test day was from 0.5 to about 1.0 kwhr, or from 5 to 10 per cent of the total cooling load. Hence the saving due to the heat-absorbing glass, expressed as a percentage of the total cooling load due to sunlight and atmospheric temperature only, was actually slightly higher than the values quoted in these tables, as these percentages are based on the total heat removed from the test houses which included the heat generated by the power used in the testing equipment.

The second set of tests was made with single windows only, the one house having ordinary glass and the other the heat-absorbing glass windows. As in the previous set of experiments, check tests were made with the house and window combinations interchanged. The results are given in Table 4.

Reviewing the results of the room cooling tests, it is very apparent that there were very considerable variations in the sunlight energy on the different test days. The total cooling load of course included conduction of heat through the windows and walls as well as the solar radiation. In the July tests when the outdoor temperatures were in general high, at the same time the high elevation of the sun reduced the effective window area, the solar radiation load due to the windows was a much smaller percentage of the total load.

Table 2—Results of Check Tests with Double Windows

Date	Weather	Max. Outside Temp. F	Time of Operation Hours	Heat Energy Removed No. 1 House Btu	Heat Energy Removed No. 2 House Btu	Saving Due to Heat-Absorbing Glass %
	No. 1 House—Double Windows—Ordinary Glass + Ordinary Glass					
	No. 2 House—Double Windows—Ordinary Glass + Heat-absorbing Heat-resisting Glass					
7/16	Sunshine with cumulus clouds.....	77	8	24810	22540	9.2
7/17	"	86	6	21210	17830	15.9
7/19	"	99	5	22140	20010	9.6
	Quite cloudy after 3 p.m.					
7/20	Cloudy until 11 a.m. then clear with cumulus clouds.....	97	3.7	18870	16550	12.3
	No. 1 House—Double Windows—Ordinary Glass + Heat-absorbing Heat-resisting Glass					
	No. 2 House—Double Windows—Ordinary Glass + Ordinary Glass					
7/22	Clear—some haze—cloudy after 4 p.m.....	83	3.7	13830	16990	18.6
7/23	Clear with few cirrus clouds.....	86	6	17200	20730	17.0
7/25	Hazy—sky filling with clouds—weather unsatisfactory until noon.....	92	7	28990	32360	10.4
7/30	Hazy with few cirrus clouds in morning —cumulus clouds in afternoon.....	92	6	17980	24180	25.7

Table 3—Test on Effect of Ventilating Slots

No. 1 House—Ordinary Glass + Heat-absorbing Heat-resisting Glass
No. 2 House—Ordinary Glass + Ordinary Glass

Date	Weather	Outside Temp. Beginning F	Outside Temp. End F	Outside Temp. Max. F	Inside Temp. No. 1 House Min. F	Inside Temp. No. 1 House Max. F	Inside Temp. No. 2 House Min. F	Inside Temp. No. 2 House Max. F	Time	Heat Withdrawn No. 1 House Btu	Heat Withdrawn No. 2 House Btu	Saving Due to Heat-Absorbing Glass %
8/21	Sunshine—Ideal	72.5	74.5	76.5	68.5	70	70	71	[a]1-2 p.m.	2210	3180	29.8
									[b]2-3	2760	3680	25.0
									[a]3-4	2880	4360	33.9
									[b]4-5	3070	4090	24.9
									Total	10920	15280	28.5

Ventilating slots in No. 2 house left open during the entire test period
[a]Ventilating slots in outside windows of No. 1 house opened.
[b]Ventilating slots in outside windows of No. 1 house closed.

Table 4—Results of Check Tests with Single Windows

Date	Weather	Max. Outside Temp. F	Time of Operation Hours	Heat Energy Removed No. 1 House Btu	Heat Energy Removed No. 2 House Btu	Saving Due to Heat-Absorbing Glass %
	No. 1 House—Single Windows—Heat-absorbing Heat-resisting Glass *No. 2 House—Single Windows—Ordinary Glass*					
9/1	Good—Few cirrus clouds	75	6	18060	21470	15.9
9/3	Clear in morning—rather dense cirrus clouds at noon—later clearing	79	6	23240	29010	19.9
9/5	Numerous cumulus clouds	76.5	6	15120	19290	21.6
9/6	Hazy in morning—cumulus clouds in afternoon	95.5	6	20410	25440	19.8
	No. 1 House—Single Windows—Ordinary Glass *No. 2 House—Single Windows—Heat-absorbing Heat-resisting Glass*					
9/28	Clear except for few cirrus clouds	69	5	16090	12220	24.0
10/8	Clear	76	6	29200	22970	21.3

Table 5—Tests to Determine Effect of Heat-absorbing Glass in Reducing Maximum Test Room Temperatures

No. 1 House—Double Windows—Ordinary + Ordinary Glass
No. 2 House—Double Windows—Ordinary + Heat-absorbing Heat-resisting Glass

Date	Weather at 9 a.m.	Max. Outdoor Temp.	Max. Room Temp. No. 1 House	Max. Room Temp. No. 2 House	Difference Due to Heat-Absorbing Glass
5/ 9	Sunshine with some clouds and haze	80 F	90 F	85 F	5 F
5/10	Semi-cloudy	89	94	90	4
5/11	Sunshine with horizon haze	75	89	80	9
5/12	Sunshine with horizon haze and some clouds	69	91	81	10
5/13	Sunshine with heavy horizon haze	73	83	77	6
5/14	Sunshine with horizon haze and some clouds	70	95	85	10
5/20	Sunshine with horizon haze and some clouds	96	110	102	8
5/28	Sunshine with horizon haze	85	100	94	6
5/31	Sunshine with horizon haze	94	110	104	6
6/ 1	Sunshine with horizon haze and some clouds	101	109	104	5
6/ 2	Sunshine with horizon haze and some clouds	100	113	108	5
6/ 4	Sunshine with horizon haze and some clouds	92	107	93	14
				Average Difference	7.3 F

Therefore, the saving due to the heat-absorbing glass was a much smaller percentage of the total heat withdrawn than on days later in the season with lower outdoor temperatures and lower sun elevation. This is readily apparent from a comparison of the results in Table 2 with the values for the open slot arrangement in Table 3. The same explanation holds for the fact that the percentage saving for single windows in Table 4 was in some instances actually greater than for the double window combination in Table 2.

An estimate of the saving in window load was made in a previous paper[3] based on the transmission data of various heat-absorbing heat-resisting glasses used singly and in combination with ordinary window glass in the inside sash. The estimated percentage saving for heat-absorbing 3 mm plate, which is practically identical with that used in the present tests, was 23.3 per cent with the single windows and 37.7 per cent in the case of the double window combination. The maximum values observed, as shown in Tables 2, 3 and 4, are 24.0 per cent for the single windows and 28.5 per cent for the double combination, and in the latter case the value is somewhat reduced because the ventilating slots were closed for part of the time. The agreement between the theoretical and observed values is reasonably satisfactory, considering the uncertainties due to weather conditions and variations in the percentage of reflected energy due to changes in the angle of the incident light on the windows.

Before the refrigerating equipment was installed, a series of tests was made to determine the effect of heat-absorbing glass alone in reducing the maximum temperature attained in the test room. In these experiments both houses were equipped with double windows, No. 1 house having ordinary glass in both sash and No. 2 house having ordinary glass in the inside and heat-absorbing heat-resisting glass in the outside sash. The ventilating slots in all the outside sash were opened to permit as much ventilation as possible between the windows. There were no fans used in the houses and the maximum temperatures were obtained from maximum-minimum thermometers which were read each morning for the previous day and then reset. The results are given in Table 5.

[3]Shaver, *loc. cit.*

Table 6—Temperatures inside Windows in Sunshine with Room Temperatures Controlled at 70 F

Date	No. 1 House: Window Arrangement	No. 1 House: Max. Window Temp. F	No. 2 House: Window Arrangement	No. 2 House: Temp. F	Difference in Max. Window Temp. F
7/16	Ordinary + Ordinary	99	Ordinary + Heat-absorbing Heat-resisting Glass	83.5	15.5
7/17	" "	92	" "	81	11
7/19	" "	98	" "	85	13
7/20	" "	96	" "	83	13
7/22	Ordinary + Heat-absorbing Heat-resisting Glass	88.5	Ordinary + Ordinary	100	11.5
7/23	" "	85.5	" "	96	10.5
7/25	" "	90	" "	101	11
7/30	" "	85	" "	94.5	9.5
8/21	" "	89.5	" "	100.5	11
9/ 1	Single Heat-absorbing Heat-resisting Glass	95	Single Ordinary	100	5
9/ 3	" "	95	" "	103	8
9/ 5	" "	98.5	" "	103.5	5
9/ 6	" "	95.5	" "	101.5	6
9/28	Single Ordinary	107.5	Single Heat-absorbing Heat-resisting Glass	91	16.5
10/ 8	" "	105	" "	95	10
				Average	10.4

The differences in maximum temperature attained in the two houses ranged from 4 to 14 F with an average of 7.3 F. These differences of course depend on the duration and intensity of the sunshine and, while on several of the test days the outdoor temperatures did not become at all uncomfortable, nevertheless the results show a very appreciable difference in favor of the heat-absorbing glass which would be of real value, for example in cases where systems of night air cooling were used.

The effectiveness of heat-absorbing glass in increasing the comfort of an individual sitting in a window where he is exposed to direct sunlight is indicated by the results of temperature measurements taken during the period when the houses were cooled to 70 F. Maximum-minimum thermometers with blackened bulbs were suspended just inside the inner window so as to be exposed to direct sunlight. The maximum temperatures attained by these thermometers during the test runs with the various window combinations are given in Table 6.

These data show that the use of heat-absorbing glass would make a very appreciable difference to an individual sitting in a window exposed to sunlight. Another characteristic of heat-absorbing glasses is the faint blue or blue-green color tint. The color in the heat-absorbing glass under test was so slight that it was not noticeable after it was installed unless called to the attention of the observer, but it has a very pleasing effect on the eyes due to reduction in light glare. It is believed that a somewhat darker shade with consequent higher heat-absorbing efficiency would be acceptable as far as color is concerned and quite desirable from the standpoint of reduction of glare.

The question of the effect of heat-absorbing glass on fuel cost in winter time is one of general interest. If this glass is effective in screening out the sun's heat in the summer time when it is undesirable, it would appear that it should be equally effective in winter weather when the sun's heat is desirable. The test houses were used to obtain some information on this point during the period from February 14 to March 28, 1934. Electric heating elements of 1500 w capacity were installed in each house and connected through a thermostatic relay which controlled the room temperature at 70 F. A fan was used to circulate the air in the room and was so placed that a constant current of air passed over the bimetallic element of the thermostat. The entire power used in each house was recorded with an electric meter. Using double windows with ordinary glass in both sash on both houses, a test run was made to determine whether or not there was any difference in the heat insulation of the two houses. The correction was applied to the results obtained with various window combinations. Table 7 gives a summary of the tests with double window combinations.

The corrected difference of 8.8 per cent increase in heat required due to the heat-absorbing glass is probably somewhat higher than would be found for a complete winter period, as the test period of 10 days in which this was obtained included 5 entirely clear days and only 2 days in which the sun did not appear at some time during the day. The comparatively small difference in the heat required with the heat-absorbing glazing in the outer sash is accounted for by the fact that the hours of sunshine per day are comparatively few during the cold season in Corning.

Another test run was made to show the heat saving through the use of storm sash glazed with heat-absorbing glass as compared with single sash containing ordinary glass. The results are given in Table 8.

Thus in cases where no storm sash are now used, the addition of an outer sash with a heat-absorbing glass for air-conditioning purposes will result in a very appreciable saving in the quantity of heat required in cold weather.

In connection with the use of heat-absorbing glass there naturally arises the question of the chemical durability of the glass, the permanency of the heat-absorbing effects, and the ability of the glass to withstand the service conditions that may be encountered. As far as chemical durability is concerned, the borosilicate

Table 7—Summary of Tests with Double Windows

House No.	Window Arrangement	Test Period	Outside Temp. Min. F	Outside Temp. Max. F	Heat Required Kwh	Difference %
1	Double—Ordinary	3/18 to 3/28	15	63	189.0	
2	" "	"	15	63	192.6	
	Correction to be applied to No. 2 House = 1.9%					
1	Double—Ordinary	2/14 to 2/24	-5	46	225.6	
2	Double—Ordinary + Heat-absorbing Heat-resisting Glass	"	"	"	250.6	
2	" " "	"	"	"	245.7 (corrected)	8.8 (Increase due to heat-absorbing heat-resisting glass)

Table 8—Test Results of Storm Sash with Heat-absorbing Glass and Single Sash with Ordinary Glass

House No.	Window Arrangement	Test Period	Outside Temp. Min. F	Outside Temp. Max. F	Heat Required Kwh	Percentage Difference
1	Single—Ordinary	2/24 to 3/5	−9	69	235.6	
2	Double—Ordinary + Heat-absorbing Heat-resisting glass	"	"	"	193.2	
2	" " "	"	"	"	189.5 (corrected)	19.6 (Saving due to addition of heat-absorbing double glazing)

heat-resisting type of glass is believed to be quite equal and may even be superior to ordinary window glass. The heat-absorbing properties are obtained by means of the chemical composition and appear to be as permanent as the glass itself. As far as service conditions are concerned, the chief requirement is that the glass should have the necessary thermal endurance so that breakage will not occur when shadows are cast across the window or a cold rainstorm suddenly chills the glass. Through the courtesy of Dr. H. M. Cook, of West Texas State Teachers' College, some tests were made at Canyon, Texas, on a set of 4 different types of heat-absorbing glass, 3 of them being of the non-heat-resisting type and one borosilicate heat-resisting. The test windows were 24x36 in. in size and approximately ¼ in. in thickness. They were puttied in the usual manner into frames which formed the covers of box-like structures about 6 in. deep, the back being of gray insulating board to simulate conditions that would exist in a building. These boxes were mounted so that the windows were normal to the sun's rays and in each case a shadow was cast across the glass by means of a board nailed across the window frame. The results are given in Table 9.

Table 9—Results of Tests on 4 Types of Heat-absorbing Glass

Date	Time	Shade Temperature	Sun Temperature	Remarks
8/ 2	2:00 p.m.	99.5 F	115 F	
8/ 3	"	97.5	111	
8/ 4	"	97.5	113	
8/ 5	"	104	115	
8/ 6	"	102	124	No. 3 checked
8/ 7	"	99.5	116.5	
8/ 8	"	102	118.5	No. 3 checked further under shaded area.
8/ 9	"	100.5	116.5	
8/11	"	104	120	No. 3 checked further.
8/12	"	106	131	No. 4 checked under shadow.
8/13	"	102	124	
8/14	"	104	122	
8/15	"	105	116.5	
8/16	"	106	125.5	Nos. 1, 3, 4 checked.
8/17	"	106	116.5	
8/18	"	105	116.5	
8/19	"	102	116.5	
8/20	"	104	111	
8/21	"	102	125.5	

No. 2 (heat-resisting, heat-absorbing glass) unbroken at conclusion of test.

The shade temperatures were undoubtedly high at the time the test was made, but the breakage was caused by the difference in temperature between the glass in the shadow and the sunlight rather than by the high atmospheric temperatures. Hence, breakage will undoubtedly occur whenever a combination of intense sunlight and shadow results in thermal stresses exceeding the thermal endurance of the sheet in question. The heat-resisting type of heat-absorbing glass with a thermal expansion coefficient slightly greater than one-half that of the usual heat-absorbing glass possesses a thermal endurance almost twice as great, giving an increased safety factor and permitting much larger sizes of heat-absorbing plate to be used.

Summary

(1) A reduction in the cooling load varying from 9 to 28.5 per cent was observed in a test house equipped with heat-absorbing heat-resisting glass used as an outside window with ordinary glass in the inside sash and from 16 to 24 per cent with single heat-absorbing glazing. The combination of double windows is theoretically much more effective than single glazing and the explanation of the above overlapping ranges of values lies in variations due to weather conditions and the seasonal change in the elevation of the sun.

(2) With no cooling equipment in operation the test house with the heat-absorbing double window combination averaged 7.3 F lower maximum temperature on sunny days than a similar test house with ordinary glass in both outside and inside sash. With air-conditioning equipment in operation, maximum recording thermometers with blackened bulbs, suspended inside the windows in the sunshine, averaged 10.4 F lower when heat-absorbing glass was used.

(3) Heat required in a 10-day period in a winter test was approximately 9 per cent more in a test house having double windows with heat-absorbing glass in the outside sash as compared with a similar house having ordinary window glass in the outside sash. A test house having double windows with heat-absorbing glass in the outside sash required approximately 20 per cent less heat than a similar house having single windows of ordinary glass.

(4) Heat-absorbing borosilicate glasses appear to have a satisfactory chemical durability and permanency of physical properties. Owing to the heating of the glass in sunlight due to the high absorption of energy, the thermal endurance of heat-absorbing glass becomes of considerable importance. The borosilicate type of glass offers a greater factor of safety owing to its low thermal expansion coefficient.

The author wishes to express his gratitude for the co-operation of various members of the Corning Glass Works Laboratory staff and their assistance in collecting the data and calculating the results, and particularly to thank Dr. Cook, Canyon, Texas, for his part of the test work.

Colors Identify Danish Pipe Lines

Copies of a new Danish national standard specifying colors and identification letters for pipe lines have been received by the American Standards Association. The colors and identifying letters are to be used on drawings of piping installations, as well as on the piping itself. Pipe lines carrying water, steam, air, brine, lubricating oil, fuel oil, smoke, waste water, and seawater aboard ship are to be distinguished by different colors and letters according to the standard.

Chicago Standards for Certified Air Conditioning

By **Samuel R. Lewis, † (*MEMBER*)**
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THE purpose of this paper is to describe the Standards for Certified Air Conditioning developed for the Chicago district by representatives of The Consulting Engineers Division of the *Western Society of Engineers,* the *Chicago Master Steam Fitters Association* and the *Chicago Ventilating and Air Conditioning Contractors Association.* These standards have been adopted by the two contractors' organizations and have been endorsed in principle by the Illinois Chapter of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and they have created much interest and discussion locally as well as in other sections of the country because of their novelty and newness.

As one of the men who developed these standards I am glad to present this discussion in the hope that it will be helpful to all who are interested in the development of air conditioning along sound engineering lines.

First let me say that there is no compulsion on anyone to follow these standards uness he wishes to make an installation which can be certified just as heating installations are certified by the *Chicago Master Steam Fitters Association.* Brief experience has demonstrated that many owners refuse to accept plants which cannot be certified as complying with these standards and it is believed that their use will be effective in improving the general quality of the work done without increasing the cost of quality results.

In many cases mistakes in computation will be discovered and corrected before it is too late, as a result of expert checking of data by an independent qualified engineer, just as countless corrections in boiler and radiator and piping selection have been discovered and corrected under Certified Heating practice. Anyone may have his plans and specifications certified for a small fee and the work is done by a regular salaried employee of the two contracting organizations. In case corrections are required no information is disclosed except to the person or firm by whom the project is submitted. The central examining staff will gladly explain the standards, but cannot design apparatus, recommend any specific type of design or system nor suggest any particular manufacturer.

If a design is certified, the combined resources of the two contracting organizations assure proper installation and operation of the plant because through their influence with the contractor supplemented by the experience and ability of the governing committees, bad workmanship will be corrected or even apparatus of manifestly improper size will be replaced.

The standards for certified air conditioning for comfort for the Chicago district were developed cooperatively because of the urgent demand by the public for some measure of protection against incompetent designs.

These standards, like any new and radical departures, were developed from the experiences of the various participants in their creation, but were scrutinized in all details with much the same care as might be given to a new municipal building code with public hearings on every clause. In this case the committee, after making an assumption, consulted with the most distinguished available authorities among engineers, contractors, architects, and manufacturers. In practically every case the standards were modified reasonably to conform with the suggestions of every communicant.

One of the interesting psychological difficulties was to persuade people to read the standards, and then having read them to make them understand that these rules simply set up limits of fair practice.

As an example of the value and desirability of having air conditioning standards it is merely necessary to cite the case of one very large installation involving hundreds of tons of refrigeration on which bids and designs were requested from various manufacturers and contractors. The bidders were furnished with floor plans of an existing building and with nothing else, but were expected to submit complete firm proposals. In this case no one knew what outside air conditions or inside air conditions should be assumed, what condensing water temperatures nor what type of compressor or refrigerant should be used.

The common experience of Chicago building owners, who heed the request of manufacturers' representatives for permission to bid on proposed air conditioning projects, has been that the proposals varied to such an extent that no confidence could be placed in the bids. Several very interesting projects for which funds were available, were abandoned, because the owner said "If air conditioning is as crazy as these proposals indicate with as much as 100 per cent difference on tonnage for the same job and if all bidders are anxious to sell me cast-iron, copper-plated guarantees, I'll just wait until I become convinced that the bugs have been driven out and you fellows learn what you are about."

Confronted with this state of affairs, the heating contractors organization approached the Consulting Engineers Division of the *Western Society of Engineers* upon the subject with the result that arrangements were made for official appointment of representatives by various interested organizations. Of a committee of seven men, five hold membership in the AMERICAN

†Consulting Engr.

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Since this paper was presented, the Chicago Committee on Air Conditioning Standards representing a cross section of the entire air conditioning industry has been organized and has completed a set of standards in somewhat different form. In these standards the results to be attained are emphasized. The methods of attaining these results are limited to suggestions embodied in explanatory notes.

It is probable that these new standards, not yet available for publication, will supersede the standards mentioned in this paper as the basis for Certified Air Conditioning. Mr. John Howatt, President of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, is Chairman of this new committee and Samuel R. Lewis is Secretary.

Society of Heating and Ventilating Engineers. At the time of organization the A.S.H.V.E. had not appointed its committee on Standards for Air Conditioning.

The first action of the Committee was to prepare a definition of air conditioning, which closely resembles the official definition adopted in 1932 by the American Society of Heating and Ventilating Engineers as a part of their Ventilation Standards.

Because of the many existing definitions of the term air conditioning and the difficulties involved in getting universal acceptance, it is evident that engineers are not of one mind on the subject.

The Chicago standards require that if an installation of Certified Air Conditioning is to be made the plans and specifications must show how the load demand was developed. Here is the clause which covers this point:

*2. INFORMATION FOR CHECKING. The plan and/or specifications of all air conditioning installations submitted under this standard shall set forth the heat transmission factors for barriers and the amounts and sources of heat loss and gain. The design temperatures and relative humidity shall be recorded for air outside and inside, also for condensing air or water, and for the heat transferring medium.

These governing design factors and temperatures shall be such as to produce an effective result at least equal to those set forth in these Standards.

This clause means about the same as a requirement that the size of a boiler for a heating system must be stated:

The clause about guarantees is as follows:

3. GUARANTEES. Guarantees of performance in specifications on which competitive bids are taken where definite minimum sizes of apparatus are specified, shall be limited to the requirement that each piece of apparatus shall deliver the rated output stipulated by its manufacturer, and that the contractor's performance guarantee shall include only the adjustment and coordination of these various capacities.

This item is an ancient bone of contention. No self-respecting consulting engineer will include in his specifications the all-embracing guarantee that the contractor must furnish everything that is omitted from the specifications which the engineer or owner might think should be furnished in order to make a complete and perfect job. An engineer is reluctant to require that the contractor, competing in price with others who perhaps are not competent or honest, shall guarantee that the sizes of apparatus which the contractor didn't select shall be big enough to do everything that every one thinks ought to be done.

The committee may modify this clause to the extent that if the owner wishes to receive from the contractor a guarantee of sufficiency and of operating performance the contractor shall be required to check the capacities of equipment and may increase such capacities at his own option, stating the difference in price if any, without prejudice or sacrifice of good will, so that all may enter into a guarantee of performance with their eyes open.

It is realized that an owner may fairly require the added insurance of a bonded contractor and may require that large sums of money shall be withheld pending fulfillment of a guarantee, provided that all concerned understand the situation.

The requirements of Item 3 require compliance with the current A.S.H.V.E. Guide for design coefficients of heat transfer through barriers and for heat from appliances, people, etc.

Design temperatures and relative humidities are specified as follows in Items 5, 6, 7, and 8:

Outside in winter.....—10F

Inside in winter.....70F and capable of producing 30 per cent relative humidity when the outside condition is 30 F and 40 per cent relative humidity, with explanations about danger of frosting.

Outside in summer....95F and 40 per cent relative humidity

Inside in summer.....80F and 55 per cent relative humidity

It is probable that a clause will be added to make clear the reasonable understanding that any Effective Temperature equivalent to 80 F and 55 per cent would be acceptable.

In Item 9 a small allowance for infiltration is provided for summer even though some people argue that infiltration in summer is ordinarily negligible. The allowance is stipulated because of the belief that when room-located unit recirculating cooling machines are used there must be local provision for condensing the moisture of inleaking air.

The stipulated allowances for infiltration are 60 cu ft per hour per square foot of all the area of windows and doors in outside barriers in winter. This is a simple approximation and does not in any way prevent the designer from computing crack width and wind velocity nor militate against his prayer that the crack will not increase or decrease nor that the wind will not blow more belligerently than at the usual 15 mile per hour rate.

The infiltration allowance when cooling is suggested as a minimum of 15 cu ft of air per hour per square foot for all of the area of these same openings and explanation is made that the sensible and latent heat for this air must be figured out and added into the load.

Minimum solar heat allowances are set forth in a very simple table as follows:

10. DESIGN ALLOWANCES FOR HEAT GAIN DUE TO SUNLIGHT. Shall not be less for each exposure than those shown by the accompanying table:

	N	NE 7 AM	E 8 AM	SE 9 AM	S 12:00	SW 3 PM	W 4 PM	NW 5 PM
Window	0	100	130	110	70	110	130	100
Skylight	0	60	100	135	180	135	100	60
Wall	0	0	2	2	2	3	3	3
Roof	0	0	0	2	4	5	5	4

The above allowances per square foot of sun-exposed area for walls and roofs are on a basic heat-transfer resistance of U-0.3 and a gray surface color. Variations in the value of U and in the color co-efficient ordinarily affect the result to a negligible extent.

(a) For restaurants and similar rooms in which the heat gain, due to occupancy and due to process work, is an important factor, the total heat including sunlight heat should be computed as of the hour when all heat other than sunshine is at the minimum.

The total heat including sunlight heat and the heat other than that from sunshine should be computed also at the hour when sunshine is at the maximum. Whichever of these two heat inputs is greater should be used.

This explanation is made to avoid possible misinterpretation and the provision of unnecessary capacity such as might be called for if the maximum heat during the 12:00 noon hour of a restaurant having a large West sunshine exposure were added to the 3 p.m. sunlight heat.

(b) When computing the refrigerating capacity for any building having many rooms and several different sunshine exposures, it will be necessary to re-compute the sunshine heat effect for the building as a whole and to use only the greatest time-direction factor for the building as a whole, in determining the tonnage.

*Sections 2, 3, 10, 11, 12, 13, 14, 15, 16, 17, 18, and 19 quoted by permission from the pamphlet, Standards for Certified Air Conditioning for Comfort issued by *Chicago Master Steam Fitters' Association.*

Otherwise, for instance, the total East sunshine heat for many rooms might be added to the total West sunshine effect for many rooms, whereas only the greater of these two sums need be provided.

(c) When computing the sunshine heat effect for any room which has more than one wall exposed to direct sunlight at any given time, only the heat input for the side having the greatest value is to be considered.

When this scheme of allowing for solar heat is worked out in practice its simplicity is appealing. There is nothing to prevent the designer from making a smaller arbitrary guess as to how much smoke there may be to reduce the sunshine intensity or as to how much faith he may place in a white wall remaining white—or in someone pulling down the awnings. The values stated are minimum values and they may well be increased. All is by no means yet known as to the lore of proper solar heat allowances.

To this end these standards have the following to say about allowance for shade from trees, buildings, and the like:

11. DESIGN ALLOWANCE FOR SHADING FROM SUNSHINE shall be made only when the plans and specifications specifically show such allowance, and give assurance that the owner is cognizant of the reduction in capacity on this account. A design reduction on account of shading, which may be temporary if the shading structure should be removed, or which depends upon human operation, is of questionable wisdom. If the shading is present, of course the operating expense will be reduced.

Item 12 covers design air quantity. The present requirements of the ventilation code of the city of Chicago for school rooms and auditoriums, factories, and similar occupied space having fixed seats, is a minimum of 1500 cfh taken from outside for each sitting. If 12 sq ft of floor is allowed per person this means approximately, 2 cu ft of air per square feet of floor per minute.

For stores this quantity is reduced to 1.8 cfm per square foot of floor for basements and to 1.5 cfm per square foot of floor for first stories.

For restaurants 1.65 cfm per square foot of floor holds, except that in kitchens, where double this amount, 3.33 cfm per square foot of floor is required or a change every 3 minutes must be provided on the basis of a 10 ft ceiling.

There is some tendency toward unofficial leniency for plants which are capable of handling code requirements when heating or when cooling without refrigeration, if during the use of refrigeration they do not recirculate more than 66⅔ of the air. This is a reasonable attitude and is said to be in effect pending adoption of the new Chicago Building Code which probably will legalize two-thirds recirculation.

This is in explanation of Items 12 and 13 of the Standards, which read as follows:

12. DESIGN AIR QUANTITY. (a) For winter air conditioning the design air quantity shall be not less than the requirements of the City of Chicago for ventilated rooms.

In rooms which do not come under the Code as of February, 1935, such as residences, a minimum air circulation of 4 changes per hour shall be provided. In such rooms where the occupancy by people is the governing factor, an air circulation of not less than 25 cu ft per minute per person shall be provided.

(b) For summer air conditioning the design air quantity shall be sufficient to extract the surplus heat at the air inlet and outlet temperatures specified, and in addition shall be not less than the requirements of the City of Chicago, for ventilated rooms.

In rooms which do not come under the Code as of February, 1935, such as residences, a minimum air circulation of 4 changes per hour shall be provided. In such rooms where the occupancy by people is the governing factor an air circulation of not less than 25 cu ft per minute per person shall be provided.

13. RECIRCULATION AND AIR FROM OUTSIDE. Provision may be made in the duct design for recirculation of not more than 66⅔ per cent of the circulated air, with 33⅓ per cent air from outside, which always shall be provided to dilute odors during occupancy. The inlets and ducts shall have sufficient capacity to permit the introduction of 100 per cent of air from outside for operation during the periods of intermediate outside temperature.

There is no particular authority for the 5 deg temperature difference suggested in sub head (a) of Item 14, except that it appeared wise to state some value. The 5 deg is a matter of judgment. In sub head (b) the rule of 2 deg per foot in height above the floor is based on the experience of the group and would allow a 20 deg temperature spread in an 11 ft ceiling provided that the inlet grille is not more than 12 in. high. Surely this seems a liberal allowance. The minimum of 100 linear feet per minute air velocity for horizontally discharging openings probably is far too low. In the judgment of some a minimum of 300 linear feet per minute would be more nearly correct. Item 14 is as follows:

14. DIFFUSION OF ENTERING AIR. The location, shape, physical characteristics of, and air velocities and temperatures through the inlets and outlets for conditioned air to the rooms shall be such as will promote distribution of the circulation throughout all occupied portions without causing discomfort.

(a) Downward discharging air inlets in rooms shall be provided with safeguards to prevent drafts at the occupied zone. These safeguards shall include plaques, injector type grilles, or other devices which shall discharge the air at an angle to the vertical and which will prevent air colder than the room air from falling vertically downward at speeds capable of causing discomfort. Unless such safeguards shall be provided, the design entering air temperature from inlets discharging vertically downward shall be not more than 5 degrees colder than the room air at the approximate level of the inlet.

(b) The difference in temperature between the entering air and the room air for horizontally discharging supply openings in side walls with conventional registers when cooling shall never exceed 2 degrees per foot in height from the floor to the bottom of the opening.

Horizontally discharging air inlets in rooms when placed higher than head level shall be designed for sufficient velocity of discharge to bring about diffusion without drafts, especially when the entering air is cooler than the room air. The minimum design air inlet velocity shall be 100 linear feet per minute. The entering air velocity may be rapid for such openings, provided that high speed jets of air do not rebound from columns, walls, etc., so as to create discomfort to people.

(c) Upward discharging air inlets in rooms shall be designed with arrangements, especially when delivering air cooler than the air in the room, so that a velocity of at least 300 linear feet per minute may be obtained so as to promote diffusion.

In Item 15 a stipulation is made that the refrigerant and the refrigerating apparatus shall comply with the rules of the Board of Health and of the *Chicago Master Steam Fitters.* These rules in a general way are no more severe than the A.S.A. Safety Code covering the installation of refrigerating apparatus sponsored by the *American Society of Refrigerating Engineers.* There are rather drastic speed limitations given for reciprocating compressors, based on the experience of the contractors organization but checked with several prom-

inent manufacturers. The speed limits were made rather low because under such circumstances the machines assuredly should have a long life and will have a desirable surplus capacity as a reserve against mistakes in estimating the demand or against possible future increases in load.

The condenser areas specified are also liberal, to provide against scale and dirt and to give a reasonable reserve capacity. The condensing water temperatures are standards and their inclusion gives a basis for reference and safeguards fair competition.

It should be explained that the specific limitations of Item 15 will be administered liberally, and that if any manufacturer should evolve some especially efficient process or device which contravenes them the Committee which is continuing will consider proper revisions.

15. REFRIGERATING APPARATUS AND REFRIGERANTS. All refrigerating and cooling equipment, piping and specialties used in connection with air conditioning shall be designed and installed in accordance with the requirements of the Chicago City Department of Boiler Inspection and Cooling Plants, the rules of the Chicago Board of Health, and the standards of the *Chicago Master Steam Fitters' Association.*

The following are minimum acceptable capacities for the various parts of the refrigerating apparatus to be used in comfort cooling:

(a) Evaporator; pressure difference between inlet and outlet not to exceed one pound per sq. in.

(b) Compressor; the load permitted on reciprocating refrigerating compressors under these standards shall not exceed the output delivered at the speeds set forth below; and the maximum operating speed shall be limited accordingly.

For Multicylinder machines delivering not to exceed 25,000 Btuh per cylinder.....400 rpm
For similar machines delivering more than 25,000 and less than 50,000 Btuh per cylinder.....360 rpm
For similar machines delivering 50,000 and less than 100,000 Btuh per cylinder.....290 rpm
For similar machines delivering 100,000 and less than 200,000 Btuh per cylinder.....220 rpm
For similar machines delivering 200,000 and less than 300,000 Btuh per cylinder.....175 rpm
For similar machines delivering more than 300,000 Btuh per cylinder.....150 rpm

It is understood that reasonable variations may be interpolated between these limiting relations as they have been taken from a plotted curve.

(c) Condenser, normal condensing pressure shall correspond to 86 F for the refrigerant used. For each 12,000 Btuh heat transfer, the effective water cooling surface shall be not less than the following:

Double pipe type, made of copper.....6 sq ft
Shell and coil type with copper coil.....8 sq ft
Shell and tube type with steel tubes and equipped with swirling devices.....8 sq ft

If other material than copper is employed correction shall be made for any difference in conductivity.

(d) Condensing water; not cooler for Chicago city water than 76 F. Not cooler for cooling tower than 80 F.

(e) Power required from the driver in no case shall exceed the manufacturer's normal rating.

(f) The receiver shall be of sufficient capacity to permit pumping out the evaporator and the liquid lines without increasing the condensing pressure more than 50 per cent above the normal pressure (corresponding to 86 F) for the kind of refrigerant used. The refrigerant should be pumped out of the evaporators and stored in the receiver during the period when the apparatus functions for heating or is exposed to room temperature of 70 or 80 F.

(g) Apparatus such as evaporators, condensing units, expansion valves, etc., shall be installed with sufficient line valves and proper fittings, to permit efficient servicing, or quick replacement of parts without exposing the interior of the refrigerant-containing parts of the system to air and moisture. Refrigerant lines shall be of proper size to prevent any appreciable pressure difference between the evaporators and the compressor.

(h) Accessibility for servicing and repair of all parts of air conditioning systems must be provided.

Item 16 deals with gages and weights and bracing of ducts and housings and reflects the experience of sheet metal contractors especially as to the calls which they have had for repairs and maintenance. Too many existing duct systems have their bottoms bulging down and leaking due not only to the periodical entry by men for cleaning purposes but also due to workmen entering during the process of erection. Some standard of this kind has been needed for a long time, though approximately the same data have been available. Item 16 is as follows:

16. METALS USED FOR HOUSINGS, TANKS, DUCTS, ETC., in air conditioning installations shall be of moisture resisting character and of such weight and with such bracing as will prevent vibration. The ducts shall be substantially air tight.

Each branch of a supply duct system shall have facilities for adjusting the air volume delivered. Preferably these dampers shall be at junction points and alternatively they may be at the registers.

If galvanized steel sheets are used they shall be not lighter than the U. S. gauges listed below with structural steel exterior bracing as shown.

Service	Gauge of Metal	Size of Bracing
Intakes	20	
Heater casings	16	
Filter, heater and other chambers	20	1¼ in. x 1¼ in. x ⅛ in. minimum.
Rectangular ducts:		
Less than 18 in. wide or high	26	
18 in. to 29 in. wide or high.	24	
30 in. to 47 in. wide or high.	22	1 in. x 1 in. x ⅛ in.
48 in. to 60 in. wide or high.	20	1¼ in. x 1¼ in. x ⅛ in.
Over 60 in.	18	1½ in. x 1½ in. x $\frac{3}{16}$ in.

If the duct has width or height of more than 24 in., there shall be transverse exterior braces for such surfaces not more than 48 in. on centers. Where "S" cleats and drive cleats are used to connect ducts, formed angle cleats may be used in lieu of the stiffener angles. The same gauges as specified above shall apply, for circular ducts of diameter corresponding to the given widths.

Some revision of Item 17 should be made since the clause concerning air filters should properly be in a separate item and should be elaborated. This new item might mention the desirability of a fireproof type of air filter. The uninitiated might be surprised to learn how often air washers have been installed without adequate waterproof safing and have thereby caused great expense and embarrassment.

17. HEAT TRANSFER APPARATUS. All convectors where condensation might occur when cooling shall have drain pans with tubing running to drip with an air break above a trapped sewer connection or its equivalent.

No fixed spray humidifier or spray dehumidifier shall be installed above the basement of a building unless there shall have been installed under it a water tight safing graded to a drain, so that in case of leakage or overflow there shall be no danger of water damage to the rooms under the apparatus.

The air velocity through the air-way of a spray humidifier or spray dehumidifier shall not exceed 500 linear feet per minute.

Eliminator plates shall be provided for spray humidifiers, for spray dehumidifiers and for evaporator-convectors and shall be made of some especially durable material so designed as easily to be replaced.

Air filters always shall be easily accessible for inspection and removal without danger of spilling dust to leeward of themselves when the substitution is made.

Item 18 deals with objectionable noise from air conditioning apparatus and merely emphasizes the suggestions made in our proceedings during many years that the floating of the foundation which carries the apparatus is more effective than merely to attempt to float the apparatus itself especially if there is a belt drive and necessity for anchoring rigidly such a thing as a small electric motor. The speed limitations for air velocity in ducts may be criticized as ultra conservative, but again the defense is that these standards cannot take into consideration proprietary devices. Assurance is given that a liberal interpretation by the plan examiner and the Chicago committee will be taken where the effectiveness of the proprietary devices is assured.

18. NOISE CONTROL. All moving apparatus used in air conditioning shall be fastened securely to its own foundations, which should be a single unit for both driver and driven apparatus, and this foundation shall be carried on a noise-inert substance such as rubber in shear, or cork under and around the edges of the foundation, without any direct contact between the foundation and the building structure.

No metal duct shall connect directly to any fan or housing without a sound-inert junction, such as of canvas.

Piping connections from pumps where practicable shall be made with rubber hose, with the machinery on a floating foundation.

Sharp edges of metal facing an air current shall be rounded or streamlined rather than left sharp and rough. Partitions, housings, and large ducts must be so heavy and so well braced that there will be no vibrating or rattling when air is being delivered.

Intermediate deflecting vanes to prevent building up undue pressure and velocity inside the outer curve of trunk line elbows are desirable.

On account of noise danger the following air velocities shall not be exceeded in those parts of the ducts of air conditioning systems closer than about 50 feet from the room outlets.

Fan outlet.....1500 lin ft per min
Trunk duct .....1200 lin ft per min
Through free area of convectors.....1000 lin ft per min

Where fans, motors, compressors, and the like are placed in rooms under or otherwise adjacent to occupied rooms, provision shall always be made to reduce noise transmission. Suggested means are double walls, double ceilings, sound absorbent material and the like.

Item 19 was called forth by experience with many plans and specifications which were hopelessly incompetent as to insulation. This item should be useful when calling attention to such discrepancies and may fulfill the need of some standard which might be cited as an example.

19. INSULATION. Insulation on pipes and air-ways when heating, is designed to reduce transmission to the surrounding air, and is under no danger of becoming moist except in case of a liquid leak.

Insulation on pipes and air-ways when cooling, in addition to reducing heat transfer from the surrounding air to the cooler inside, must prevent the surrounding air from reaching its dew point and thus depositing moisture. The dew point temperatures for conditions of the air around a cool duct or pipe may be read from a psychrometric chart, but are suggested as follows:

	Air Touching the Cool Surface					
Temperature of Cool Surface	DbF	Rh at DP	DbF	Rh at DP	DbF	Rh at DP
40	60	48%	70	34%	80	25%
45	60	58%	70	40%	80	29%
50	60	70%	70	50%	80	35%
55	60	85%	70	60%	80	42%
60	60	100%	70	70%	80	50%

This indicates that if a cold surface at 40 F is permitted to cool the air which comes in contact with its outer surface, to 60 F and 48 per cent Rh there will be a deposit of moisture akin to that which one sees in summer beading the surfaces of uninsulated cold water pipes in basements.

In air conditioning in which refrigeration is used, therefore, all chilled surfaces must be insulated not only as a measure of control of heat waste, but also to prevent damage due to water drip.

For ducts carrying air not colder than 40 F, a ½ in. layer of board or quilt insulation will serve, provided that the chilled areas are all covered so that air does not pass against the cold surface. For housings around evaporators and for spray dehumidifier housings ½ in. of quilt insulation and ½ in. of board insulation with alternating joints and thorough sealing, have given satisfactory service. Cork 1 in. thick properly sealed, gives satisfactory results, especially for spray dehumidifier housings which carry direct expansion evaporators also.

For low side refrigerant piping cork insulation is acceptable, of thickness commensurate with the temperature difference.

For systems which use cold water piped to the convectors for summer only, any anti sweat pipe insulation 1 in. thick, is acceptable. Where the same pipes convey hot water in winter and cold water in summer, a combination insulation shall be used, which will withstand both extremes. Compressed mineral wool has this faculty, though there is evidence that any good quality steam pipe insulation will serve satisfactorily provided that there are no exposed chilled surfaces to condense the damaging dew.

The standards end with pertinent extracts from the city codes covering local requirements as to permits and fees and quotes local rules as to certain safety features. The situation concerning evaporators for chemical types of refrigerant placed in air ducts of ventilating systems is not entirely satisfactory and undoubtedly must be clarified soon.

There are many large factories having work rooms crowded with employees with inadequate exits to the outer air which are cooled by direct expansion ammonia, sometimes in convectors and frequently with direct expansion coils in air washers where they are sprayed with water. Some experienced refrigerating engineers defend this practice. Others equally experienced condemn it. The Chicago building code prohibits such practice, and the Standards for Certified Air Conditioning rest on the Code.

There is need for clarification of this matter and research may be required because there is such a wide variation in the properties of the refrigerants now in common use, and in the pressures and in the kinds of metal and in the safety devices.

Many engineers fear that some serious accident may happen before proper restrictions and safeguards shall have been developed and enforced. A suggestion is made that this particular matter properly might be pursued further by a joint Committee of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and the *American Society of Refrigerating Engineers.*

The Committee which developed these standards for Chicago realizes that improvements can be made and hopes to keep them from becoming too detailed and too voluminous. Changes can be made from time to time as experience in administering them dictates.

Heat Conductances of Adobe

By **Hugh M. Milton, Jr.*** *(NON-MEMBER)*

State College, New Mexico

NATURAL earth structures were the first homes of civilization and are to be found in all countries of the globe. Alike in its resistance to tropical heat and wintry blasts natural earth or adobe was recognized as a building material that could support its own weight and a superimposed roof load, easily obtained and easily fabricated. In the southwestern portion of the United States there are many adobe structures reminiscent of civilizations long forgotten, thus demonstrating its durability and resistance to erosion. In the city of Santa Fe, New Mexico, there still stands the Palace of the Governor, in a splendid state of repair, which dates back to 1609, and in one of the puebloes of the same state there is still used a one room adobe hut, which the tribal legend states was built about 890. With such evidence of its durability, its compressive strength great enough to support a wall two stories high and its often observed resistance to heat flow, there is no wonder that earth has become the "standard" building material of some of the communities of the southwest.

The term usually applied to earth used for building material is "adobe," but there is no established standard of the consistency of the material. A clay loam soil is the most desirable; however, if the percentage of clay is too great there will be cracking of the material upon drying. A certain amount of sand is always necessary, but the exact percentage has yet to be determined. Recent experiments conducted at the New Mexico State College would indicate that the following limits would obtain for the most desirable results:

Clay—75% to 43%.
Sand—25% to 30%.
Silt—0% to 8%.

The mixtures given will result in brick or poured walls with little cracking and applicable to all types of earth wall structures.

The following are recognized methods of using earth for wall structures:

1. Cajon—Earth is poured between two lathed walls.
2. Poured adobe sometimes called mud concrete—Wall is poured into form and then the form removed.
3. Cob—Adobe blocks are cut directly from the earth and placed one above the other and joined together with the same mud.
4. Rammed earth the same as the poured earth, but rammed during the process of pouring.
5. Adobe brick or sun dried brick—earth is mixed with straw or grass and placed in form 4x8x16 in. and dried in the sun.

By far the most common type of earth buildings are built with sun dried brick as they are easily made and placed in the wall and can be transported. Regardless of the type of wall structure a house built of adobe will be warm in winter and resist the heat of summer. This quality alone possibly was responsible for its universal use in the near tropic temperatures of the southwest.

Little is known specifically of its heat resisting qualities although it is accepted as a very desirable insulator. Many instances have been observed where it has been used for covering of boilers and other heat exchangers. Recently a series of tests were made at the New Mexico State College to ascertain the coefficient of heat transfer and the results of these tests show adobe to rank as one of the best insulators.

Tests were run by the standard hot box method; however, due to the impossibility of arching without the introduction of other materials, it was first necessary to contruct a box of matched lumber 34 in. on the side. The coefficient of heat transmission was then obtained for this box, after which the sides of the box were removed and replaced with an 8 in. adobe wall. The heat supplied was from a bank of electric bulbs and circulation was obtained by a fan, all of which were controlled from outside the box. The electrical power input was determined by means of a watt-hour meter and then converted to heat units. Knowing the total heat lost through the six surfaces of the box and having definitely determined the coefficient of heat transmission of the wooden surfaces, the net heat radiated by the adobe walls was obtained. Hence the coefficient of the heat transmission of the adobe U_a was calculated from the following equation.

$$U_a = \frac{H}{A(t - t_o)}$$

Where

U_a = Btu radiated per square foot per degree difference per hour.
A = Net area of adobe walls.
H = Heat transmitted through adobe.
t = Inside air temperature of box.
t_o = Outside air temperature of box.

A wall thickness of 11 in. was used for the first series of tests. After U_a was secured for the bare wall the box was plastered inside and another series of tests made. Then stucco was placed on the outside wall and the coefficient was determined. After the data were obtained for an 11 in. wall the stucco was removed and the wall built to a thickness of 16 in. and the tests repeated. The tabulation herewith shows the results obtained, and by comparing with the results obtained with other building materials it is seen how favorably adobes compare.

Wall	Coefficient of Heat Transmission
11 in. — bare adobe	0.281
11 in. — adobe + plaster	0.259
11 in. — adobe + plaster + stucco	0.2375
16 in. — adobe + plaster	0.1925
16 in. — adobe + plaster + stucco	0.1825

*Dean of Engineering, New Mexico State College of Agriculture and Mechanic Arts.

Substituting in the established equation

$$U = \frac{1}{\frac{1}{F_1} + \frac{1}{F_0} + \frac{X_1}{K_1} + \frac{X_2}{K_2} + \frac{X_3}{K_3}}$$

Where U is the coefficient of heat transmission. (Btu radiated per hour per square foot of heating surface per degree difference in temperature.)

F_1 and F_0 inside and outside surface coefficients respectively for the material in contact with air, X_1, the thickness of the adobe, X_2, the thickness of the plaster, X_3, the thickness of the stucco, K_2, the conductivity of the plaster (assumed 3.3), K_3, conductivity of the stucco (assumed 12.0), K_1, conductivity of the adobe.

The mean temperature for this preliminary test was held as near 110 as possible. Over the series of five tests the mean temperature actually was 109.94 F. The average conductivity for this mean temperature was found to be 3.58.

A. S. A. Piping Standards Adopted

Forty national organizations participated in the preparation of the American Standard Code for Pressure Piping and final approval has been given this code under the procedure of the *American Standards Association.*

The Code represents seven years of intensive work by a Sectional Committee and its principal provisions cover the following points:

(1) Choice of suitable materials and reference to specifications covering these materials;

(2) Designation of proper dimensional standards and methods of fabrication for the elements comprising piping systems;

(3) Listing of suitable formulas and requirements for the design of these elements and their supports;

(4) Erection of piping systems; and

(5) Testing of the elements before erection and the completed systems after erection.

The Code is described as primarily a safety standard establishing minimum requirements to which piping systems must conform. Installations such as building heating systems operating at less than 15 lb gage pressure, plumbing sprinkler systems, roof and floor drains are exempted from the scope of the Code.

It is intended to set minimum safety requirements but not to cover the best practice known to the art. While in most cases the requirements are mandatory, design recommendations have been included where they will be of assistance in securing safe piping systems.

In general, the Code is applicable only to piping systems which are to be operated at service pressures or temperatures up to the maximum limits specified for the materials covered. The maximum limiting temperature specified through the Code is 750 F except in the case of oil piping where temperatures as high as 1100 F are permitted in some cases.

The Code is not retroactive and does not apply to piping systems, erected before, or under erection at the time of its approval by the *American Standards Association.* It is expected to serve as a guide to state and municipal authorities in the drafting of their regulations and also as a standard reference for minimum safety requirements by equipment manufacturers, architects, engineers, erectors and others concerned with pressure piping.

The Code is subdivided into sections, each dealing with a particular kind of piping. Power piping, gas and air piping, oil piping, and district heating piping are covered. Each of these sections was prepared by a subcommittee of experts in that particular field. In addition to these sub-divisions provision was made for two sections of a general nature applying to all services, which deal with available materials, specifications and fabrication details.

The Committee members are: E. B. Ricketts, *Edison Electric Institute,* Chairman; F. A. Lydecker, *American Gas Assn.,* Secretary, and:—

American Society of Mechanical Engineers, Sponsor, Arthur M. Houser, Alfred Iddles, C. S. Robinson, A. C. Badger (alt.)

American Gas Association, H. C. Cooper, Frederick Lydecker

American Institute of Chemical Engineers, F. J. Metzger

American Institute of Consulting Engineers, G. A. Orrok

American Marine Standards Commission, H. C. E. Meyer

American Petroleum Institute, C. A. Ellis, Charles Fitzgerald, J. S. Hess, A. D. Sanderson

American Society of Refrigerating Engineers, Alvin H. Baer

American Society for Testing Materials, Frank N. Speller, George H. Woodroffe

American Steamship Owners' Association, J. F. MacMillan

American Transit Association, George G. Hollins

American Water Works Association, Frank N. Speller

American Welding Society, J. L. Anderson, Alfred G. Oehler (alt.), F. C. Fyke

Associated Factory Mutual Fire Insurance Companies, H. B. Stewart

Association of American Steel Manufacturers Technical Committees, L. B. Grindlay, Thomas G. Stitt

Association of Edison Illuminating Companies, Abbott L. Penniman, Alexander Maxwell (alt.)

Cast Iron Pipe Research Association, Edward Hering, J. W. Moore, H. Y. Carson (alt.), Thomas F. Wolfe

Compressed Air Manufacturers Association, Henry S. Smith, H. H. Moss (alt.)

Copper and Brass Research Association, William G. Schneider

Edison Electric Institute, Edwin B. Ricketts

Heating, Piping, and Air Conditioning Contractors National Association, E. W. Verity

Hydraulic Institute, Martin B. MacNeille

International Association of Industrial Accident Boards and Commissions, A. L. Wilhoite

Manufacturers Standardization Society of the Valve and Fittings Industry, John J. Harman, F. Hugh Morehead, William Hein (alt.), Arthur M. Houser (alt.), Gus A. Daeuble (alt.)

National Association of Building Owners and Managers, George W. Martin

National Association of Practical Refrigerating Engineers, J. R. Bernd

National Automatic Sprinkler Association, J. Howard Williams

National Bureau of Casualty and Surety Underwriters, A. C. Gordon, W. M. Graff (alt.)

National District Heating Association, Sabin Crocker, J. H. Walker (alt.)

National Electrical Manufacturers Association, S. C. Osborne

National Safety Council, Henry S. Smith

New England Water Works Association, Frank N. Speller

Ohio Society of Safety Engineers, J. Henry Vance

Power Piping Society, Henry E. Haller, Geo. J. Stuart (alt.)

Refrigerating Machinery Association, Fred Nolde

Society of Naval Architects and Marine Engineers, Henry C. Meyer

U. S. Department of Agriculture, W. L. Edwards

U. S. Department of Commerce, J. L. Crone, H. L. Whittemore

U. S. Department of Labor, Martin McCue, William Alderman McGregory (alt.)

U. S. Navy Department, Bureau of Construction & Repair, Chief of Bureau

U. S. Navy Department, Bureau of Engineering, Officer in Charge

U. S. Navy Department, Bureau of Yards & Docks, L. W. Bates

Water Works Manufacturers Association, Howard A. Hoffer

Members-at-large, Davis S. Boyden, G. S. Coffin, S. F. Delaney, S. F. Dockstader, Harry D. Edwards, E. R. Fish, Oliver S. Hagerman, J. S. Haug, E. B. Severs (alt.), Herman C. Heaton, Frank W. Martin (alt.), Howard Hoffer, L. C. Killen, John H. Lawrence, Edward Lenz, Harold H. Morgan, William S. Morrison, Albert W. Moulder, Edward W. Norris, G. W. Satthoff, G. K. Saurwein, Clarence G. Spencer, C. C. Spreen, J. Roy Tanner, Fred H. Wagner, M. A. Walker.

Chicago for the Meeting and Exposition

THE 42nd Annual Meeting of the Society is to be held at the Palmer House, Chicago, Ill., during the week of January 27, 1936. The members of the Illinois Chapter will be hosts for the occasion and J. H. Milliken is Chairman of the Committee on Arrangements. The program for the Technical Sessions is being prepared by the Program Committee, Albert Buenger, *Chairman*, F. E. Giesecke and O. W. Ott, and the subjects will provide for the discussion of such interesting topics as air bacteriology, heat transmission through concrete, heat transfer of fin tubing, and corrosion in steam heating return lines.

The Society's Research Laboratory and several cooperating institutions will report the results of investigations which have been carried on during the past year.

Reduced fares to Chicago will be available to members and they will have the opportunity of spending a very pleasant week in Chicago attending the sessions of the Society and visiting the 4th International Heating, Ventilating and Air Conditioning Exposition which will be held in the International Amphitheatre.

N. W. A. H. A. C. A.

H. T. Richardson, President of the *National Warm Air Heating and Air Conditioning Association*, announces that the Board of Directors has chosen Chicago for its winter meeting and will hold a three-day session at the Stevens Hotel during the week of January 27. Business and technical sessions will be held and the members will also have the opportunity of attending A. S. H. V. E. meetings and the Heating and Ventilating Exposition.

The Exposition

The 4th International Heating, Ventilating and Air Conditioning Exposition has been announced by C. F. Roth and it will be held at the International Amphitheatre in Chicago, January 27 to 31, 1936. For the first time this exposition will be held in Chicago. A record attendance is anticipated and it will be interesting to see those who come to this heating, ventilating and air conditioning show to witness the progress of civilization graphically represented by the actual equipment in operation that illustrates the most advanced methods for providing comfort and controlling atmospheric and processing conditions. A representative number of leading manufacturers have reserved space in this Exposition which is held every two years and it is believed that the Chicago Show will be the largest in the series of expositions which started in 1930.

Current public interest in comfortable surroundings increases year by year and the trend is evidenced by the installation of heating and air conditioning equipment in residences, apartments, hotels, theaters, office and industrial buildings.

The Society's Exposition Advisory Committee is: John Howatt, *Chairman*, Chicago Board of Education; John M. Frank, Ilg Electric Ventilating Co.; F. H. Gaylord, Hoffman Specialty Co.; R. E. Hattis, Consulting Engineer; A. B. Martin, Kewanee Boiler Co.; E. M. Mittendorf, Sarco Co.; J. R. Vernon, Johnson Service Co.

A Cooperating Committee of representatives from allied organizations is as follows:

J. J. Donovan, *American Oil Burner Association;* J. L. Harpham, *National Association of Air Filter Manufacturers;* N. T. Sellman, *American Gas Association;* S. C. Bloom, *American Society of Refrigerating Engineers;* J. C. Matchett, *Steam Heating Equipment Manufacturers Association;* G. H. Dickerson, *Heating, Piping & Air Conditioning Contractors National Association;* R. W. Blanchard, *Register & Grille Manufacturers Association;* H. T. Richardson, *National Warm Air Heating & Air Conditioning Assn.;* Homer Addams, *Steel Heating Boiler Institute;* J. R. Whitehead, *Stoker Manufacturers Association;* E. W. Smith, *Institute of Boiler & Radiator Manufacturers.*

Cleveland Chapter

May 27, 1935. A dinner meeting was held at the Allendorf Restaurant and was called to order by Pres. M. F. Rather at 7:45 p. m. with 41 members and guests present. H. M. Nobis, treasurer, reported $50.60 in the commercial account and $262.36 in the savings account and asked that the Finance Committee audit the books for the past year. G. B. Longcoy, Chairman of the Finance Committee, was instructed to give a financial report at the June meeting.

The Nominating Committee, composed of C. F. Eveleth, Chairman, F. A. Kitchen and W. E. Stark, submitted the following list of candidates for office for the coming year:

President—G. L. Tuve.
Vice-President—E. J. Vermere.
Secretary—Philip Cohen.
Treasurer—H. M. Nobis.
Board of Governors—M. F. Rather, F. R. Dickenson, L. T. Avery.

President Rather called for additional nominations from the floor and as none were presented, it was moved and seconded that the nominations be closed and that ballots be sent to all members prior to the annual election in June.

W. E. Stark, a member of the Society's Council, submitted a report, which was presented by Mr. Eveleth, regarding suggested changes to the Society's Constitution and By-Laws in the method of selecting members of the A. S. H. V. E. Nominating Committee. President Rather appointed a committee consisting of C. F. Eveleth, L. T. Avery, and R. G. Davis to study this matter and report at the June meeting.

At 8:15 p. m. Professor Tuve took charge of the meeting and introduced the speakers, each of whom covered one particular phase of Residential Air Conditioning.

The first subject, Summer and Winter Design Conditions, was discussed by Mr. Eveleth and covered the selection of proper indoor and outdoor temperatures.

H. E. Wetzell, the second speaker, spoke on Summer and Winter Economics of Insulation, Weather Stripping, Awnings and Shades.

Winter Air Conditioning in a Warm Air Heated Residence was presented by F. A. Kitchen.

George Nachman spoke on Winter Air Conditioning in a Radiator Heated Home and the subject of Summer Air Conditioning for a Warm Air and Radiator Heated Residence was covered by L. T. Avery.

F. A. Rodgers was the final speaker and discussed the Need of Automatic Controls.

Secy. E. J. Vermere reports that the meeting adjourned at 11:00 p. m., after which refreshments were served.

Subcommittees of A. S. A. Standards for Drawings

When the preparation of the American Standard for Drawings and Drafting Room Practice was undertaken by the *A. S. A.* and cooperating organizations, the work was divided into six important phases of drawing, namely:

Subcommittee on Specifications for Paper and Cloth—A. A. Coburn, *Chairman,* Washington, D. C., representing the U. S. Army Chief of Ordnance;

Subcommittee on Methods of Indicating Dimensions—E. B. Neil, *Chairman,* mechanical engineer with N. W. Ayer and Son, Inc., Detroit, Mich.;

Subcommittee on Lettering—T. G. Crawford, *Chairman,* General Electric Co., Schenectady, N. Y.;

Subcommittee on Drawing Layout—F. G. Wolff, *Chairman,* American Car and Foundry Co., New York, N. Y.;

Subcommittee on Line Work—Samuel Ketchum, *Chairman,* Treadwell Co., Inc., New York, N. Y.;

Subcommittee on Graphical Symbols for Drawings—G. H. Drake, succeeded by Prof. T. E. French, *Chairman,* Ohio State University, Columbus, O.

D. S. Boyden, Boston, Mass., represented the American Society of Heating and Ventilating Engineers on the Sectional Committee.

PRESIDENT'S MESSAGE TO MEMBERS

SPACE COOLING

While cooling is but one of several functions in the process of air conditioning, it is the one that has the popular appeal at this time and the one that is responsible for the rapid increase in the industry in recent years.

Research into the response of humans to their air environment developed the fundamental data that made possible the growth of the air conditioning for comfort industry. The development of equipment and space cooling practices is still far from static and many changes may be looked for within the next five years. But whatever changes in appliances and their uses may come, the performance as measured by the occupants of the cooled space must always provide maximum comfort. There must always be maintained in the zone of occupancy a proper relationship between the dry bulb temperature, the wet bulb temperature and the air motion, for comfort cooling is more than merely lowering temperature.

The cost of comfort cooling installations is high and there is always the temptation to reduce it by recirculating too large a part of the air handled. When this is attempted in rooms in which there is tobacco smoke or odors, a deposit is made on the coils which soon causes foul, stale, objectionable odors in the room. Result, a dissatisfied customer.

IT IS MORE IMPORTANT THAT WE HAVE SATISFACTORY AIR CONDITIONING INSTALLATIONS THAN THAT WE MERELY HAVE A GREAT MANY OF THEM.

September 1, 1935.

John Lennox — President,
American Society of Heating and Ventilating Engineers.

OF INTEREST TO MEMBERS

CLINTON H. QUIRK has joined the Trane Company, LaCrosse, Wis., and will have headquarters in New York so that he may be closely in touch with activities in the eastern territory. For many years Mr. Quirk was in the Vento Division of the American Radiator Co.

J. NEAL SAWYER, Kansas City, Mo., recently entered sales engineering work for the Air Conditioning Engineering Corporation.

THE VANCE-MCCREA SALES CO., Baltimore, Md., will represent the Dail Steel Products Co., Lansing, Mich., according to a recent announcement.

THE RICHMOND RADIATOR CO., Uniontown, Pa., has announced a full operating schedule for the manufacture of boilers, radiators and enamel-ware following its purchase by Reynolds Metal Co., Inc., New York. G. A. Robertshaw has been elected Chairman of the Board, R. S. Reynolds is a Director, H. M. Kelly, Secretary and Assistant Treasurer, H. F. Hagendoran, Treasurer, and C. C. Adams is now Manager in charge of sales. The general offices of the company moved to Uniontown on August 1.

Joint Committee on Refrigeration

A meeting of the joint committee on Rating Commercial Refrigerating Equipment sponsored by the *American Society of Refrigerating Engineers* will be held at the Cleveland Hotel, Cleveland, Ohio, September 4 and 5.

Recently President Howatt announced the appointment of the following A. S. H. V. E. representatives on this Committee: Messrs. W. E. Stark, Cleveland, C. W. Walton, Jr., New York, N. Y., and D. W. McLenegan, Schenectady, N. Y.

The purpose of the Committee is to prepare and recommend rating and test methods for mechanical condensing units and air conditioners used in combination with them and the work is being carried on by representatives of *A. S. R. E., N. E. M. A., R. M. A., A. C. M. A.* and A. S. H. V. E.

Safety Congress in Louisville

The Twenty-fourth Annual Safety Congress and Exposition will be held at Louisville, Ky., October 14 to 18, 1935, according to the announcement of W. H. Cameron, Managing Director of the National Safety Council. Altogether 125 separate meetings of the many sections of the Council have been scheduled and a very important educational exhibit will be held. Safety equipment to be featured will include air conditioning, dust collecting and control, fire protection, mechanical guards, respiratory equipment, etc. The Industrial Health Section will consider first aid, industrial health service, heat exhaustion and occupational diseases, and the Refrigeration Section will consider safe use of tools, machinery hazards and protective equipment.

Moody and Hutchison Consultants

L. E. Moody and J. E. Hutchison, formerly associates of the late Isaac Hathaway Francis, will continue the practice of consulting engineering under the firm name of Moody and Hutchison, with offices in the Architects' Building, Philadelphia. It is announced that the work of the new firm will include engineering service along mechanical and electrical lines of which heating, ventilating and air conditioning will be an important part.

A Big One

The accompanying picture of a big one that did not get away from Prof. M. K. Fahnestock of the University of Illinois is ample evidence that the fishing was good back in the woods where the Professor spent his vacation. This 32½-lb "muskie" put up a real battle. Have the Professor tell you the story some time.

Lawler Joins Harbula and Associates

Matthew M. Lawler has become associated with M. G. Harbula and Associates, Wheaton, Ill., consulting air conditioning engineers, according to an announcement just issued.

For the past year Mr. Lawler has been the resident manager of the Hitchen Engineering Co., Chicago, and prior to that for several years he was Los Angeles manager for Cooling and Air Conditioning Corp. He has handled a number of large and unusual air conditioning projects, some of the outstanding installations being the Southern California Edison Co. Building and the Higgins Building, in Los Angeles; California Institute of Technology, Pasadena, Calif., and the Security Office Building, Phoenix, Arizona.

In 1928 Mr. Lawler joined the Cooling and Air Conditioning Corp. as air conditioning engineer in New York and in 1930 he went to California as District Manager. When Mr. Lawler graduated from the Stevens Institute of Technology in 1925, he was employed in New York by Drying Systems, Inc., and for three years served as draftsman, serviceman and engineer.

Col. Graham Appointed Dean of Engineering

The Board of Trustees at the University of Kentucky, Lexington, has announced the appointment of Colonel James H. Graham as Dean of the College of Engineering to succeed the late Dean F. Paul Anderson.

Colonel Graham graduated from the University of Kentucky, receiving his degree in civil engineering in 1900 and until 1917 he was engaged in railway, mining and other construction work. From June 1917, when he became captain in the Corps of Engineers, U. S. Army, he organized and operated supply depots, constructed railways, docks, and storage facilities for the A. E. F. For his services he received the Distinguished Service Medal and the French government conferred the rank of Officer in the Legion of Honor.

Since the war, Colonel Graham has been engaged as a con-

sultant in engineering and industrial work both here and abroad and also served as President of the Indian Refining Company.

Last year Colonel Graham's book, "Joseph, the Husband of Mary," was published.

Dust Control

The Determination of Control of Industrial Dust by J. J. Bloomfield and J. M. DallaValle has been issued as Public Health Bulletin No. 217 of the United States Treasury Department, Washington, D. C. This bulletin of 167 pages is divided into twelve sections and a bibliography. The bulletin presents the methods and instruments used in conducting test studies in industry, discusses their practical application and gives valuable information to engineers, chemists, and others interested in the control of the dust hazard.

New Warm-Air Heating Book

The new book, Gravity Warm-Air Heating, just issued, provides the profession and the industry with a convenient volume of data developed through years of research work at the University of Illinois.

When it was proposed to publish in book form, the material published in the several warm-air heating bulletins issued by the Engineering Experiment Station, it was hardly anticipated that the volume would exceed 500 pages.

Its contents comprise the material presented in Bulletins No. 112, 117, 120, 141, 188, 189, 230, 246, 263 and Circular No. 15. The material was collated by Prof. James D. Hoffman, past president, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and director of the Department of Practical Mechanics, Purdue University, Lafayette, Ind.

The text includes a complete description of the testing plants, an outline of the methods of testing and the results of the tests. Because of its contents, this book must not be considered a work for those engaged only in gravity warm-air heating, as there is a great deal of basic information in it for those interested in heating with air. One may find in its pages authoritative data on such subjects as the effect of wind and sunshine; temperature of castings; heating effect of elbows and leaders; amount of water evaporated in humidity pans; relative values of bright and covered pipes; heating costs with different fuels; conditions when condensation appears on windows; draft in average small residence chimney; heat lost in flue gases, and similar subjects.

This book has been published by the *National Warm Air Heating & Air Conditioning Association*, primarily to make available all of the data developed by research. The cost of the book is $2.00 a copy.

Heating and Air Conditioning

The popular term Air Conditioning has claimed the current appeal of another title of a well known text book on heating and ventilation by John R. Allen and James H. Walker in their fourth edition.

Heating and Air Conditioning is the title of this new book which is intended primarily for engineering and architectural students. Because of the recent advance in the art of air conditioning this book has been revised to include many of the popular phases of this important subject.

Most of the chapters of this book have been revised to conform to the best practices and certain material on heating has been condensed to allow for additional data on cooling.

The first part of the book covers the field of heating with chapters on warm air furnaces, radiators, fuels, boilers, steam and hot water systems, piping, central or district heating, and methods of heat loss calculations. Half of the book is devoted to the subject of ventilation and air treatment with a chapter on the fundamental properties of air including tables and charts.

Considerable space is devoted to the factors affecting human comfort, with charts and references from the research work conducted at the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS' Research Laboratory. The subjects of refrigeration and artificial cooling are mentioned to completely cover the essential parts of an air conditioning system along with filters, washers, humidifiers, and temperature control apparatus.

This book of 435 pages is published by the McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y., and is priced at $4.00 per copy.

Fans

The author of a new book entitled Fans, has intended to accumulate in a single volume much of the work of individual investigators and manufacturers of fan equipment. Although it is the intent of the author to present material which would be of value to the purchaser of fans, it is doubtful whether this is the real value of the book, as the greater part of its contents can only be interpreted by those who have knowledge of the basic laws of science.

The first part of the book contains many illustrations of various types of fan equipment and brief descriptions of their application to industrial and ventilating installations. Basic fan laws and their relation to certain laws of performance which are useful in determining the effect of certain changes in the conditions of operation are adequately covered in two chapters.

The theory and design of several fan blades, including propeller characteristics are discussed, with detailed cuts and sketches to illustrate the text material.

One chapter contains information regarding the standard methods for testing and rating fans. The Standard Test Code for Disc, Propeller and Centrifugal Fans and Blowers, prepared by the joint committee of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, and the *National Association of Fan Manufacturers* is included in this chapter.

A valuable adjunct to the book is several bibliographies which follow each one of the chapters giving additional sources of information on this subject.

Fans, by Theodore Baumeister, Jr., of New York, contains 236 pages, is bound in cloth, and sells for $3.50. It is published by the McGraw-Hill Book Co., 330 West 42nd Street, New York, N. Y.

A. S. M. E. Annual Meeting Technical Program

For the technical program being arranged for the Annual Meeting of the *American Society of Mechanical Engineers*, to be held in New York, December 2-6, 1935, thirty-six technical sessions are being planned. The following Divisions will take an active part: Fuels Division, 3 sessions; Power Division, 3 sessions; Railroad Division, 2 sessions; Applied Mechanics Division, 2 independent sessions and 2 joint sessions; Process Industries Division, 4 sessions; Machine Shop Practice Division, 2 sessions; Hydraulic Division, 2 sessions.

Sessions on education and training, textiles, iron and steel, oil and gas power, petroleum, steam research, safety, wood industries, boiler feedwater, power test codes, and mechanical springs are also being arranged.

The power program is one of the most extensive of any annual meeting in recent years. One of the Power Division's sessions on thermodynamics will be held jointly with the Applied Mechanics Division, and will include a paper on the viscosity of water and steam which will give the results of research work on the critical-pressure boiler at Purdue University. Other steam-power sessions include a 5-year progress report, a paper on pipe bends, and another on creep of steel in power applications. A third session will cover boiler circulation and the maintenance of condensers.

The Fuels Division sessions include a symposium on zoned and metered air control for underfeed stokers, a paper on electrostatic precipitators for stoker-fired boilers, and two other symposiums, one on the life of various types of furnace bottoms for

tapping ash in the molten state, and the other on the selection of coal for underfeed stokers. The Fuels Division will also sponsor a session on radiant heat in furnaces, which is being organized by the Research Committee on Radiant Heat in Boiler Furnaces, of which W. J. Wohlenberg is chairman. The Boiler Feedwater Studies Committee has planned a program of papers on recent research and tests of boiler feedwater and turbine corrosion.

The Oil and Gas Power Division will present papers on operating costs of Diesel-electric generating stations, and on film lubrication theory and engine-bearing design. There will also be the yearly report on oil-engine power costs for the year 1934 which will be formally presented and discussed. This report, which will cover more than 150 plants, will be on sale in the fall.

The hydraulic sessions will be held jointly with the Power Division of the *American Society of Civil Engineers* and will discuss cavitation problems, turbines, propeller pumps, and the progress in cavitation research.

The sessions of the Process Industries Division are of special interest this year. The Heat-Transfer Committee of this division will have two sessions on radiant heat and will cooperate with the Fuels Division in a session on radiant heat in boiler furnaces. Two other sessions will contain papers on automatic control of sugar pans, flash drying, and mechanical dust collection.

The Petroleum Division will present papers on heat-recovery design for petroleum refineries, automatic control of refinery operation, and design of vertical oil-storage tanks.

The Textile Division will have a joint session with the Graphic Arts and the Management Divisions.

Hershey Air Conditions Office

The Hershey Chocolate Corp. is now erecting a new building at Hershey, Pa., to house the executive offices. The building has no windows, but a freshly conditioned air supply will be provided according to the plans which were made by D. Paul Witmer and A. Bowman Snavely. The building will be insulated to reduce the summer cooling load and the winter heating load. Two air conditioning systems will provide maximum comfort and it is planned to maintain 80 deg dry-bulb and 65 deg wet-bulb in summer, and 75 deg dry-bulb and 48% relative humidity during the winter.

Smoke Study in New York

At a conference with Deputy Health Commissioner Sol Pincus of New York City, Wm. G. Christy, Smoke Abatement Engineer in charge of the anti-smoke campaign in Hudson County, discussed plans for a comprehensive survey of smoke and air pollution in greater New York.

Commissioner Pincus explained that the New York Smoke Survey has been approved as a project of the Works Progress Administration with an appropriation of about $300,000.00 annually. He stated that some 150 engineers, chemists and scientists will be employed on this work.

The air pollution survey will be carried on by the New York Department of Health in cooperation with the WPA. The New York Health authorities expect to determine the sources of all air pollution, the damage done to structures and merchandise, as well as the effects on health. It is anticipated that the work may take two years time.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 27 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by Sept. 16, 1935, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
APT, SANFORD R., Mech. Engr., U. S. Government, Washington, D. C.	C. S. Leopold J. L. Nagle (*Non-Member*)	C. A. Peters, Jr. (*Non-Member*) R. R. Galloway (*Non-Member*)
BLAKESLEE, DONALD, Engr., Donald Blakeslee, Inc., Patchogue, L. I., N. Y.	Arthur Ritter F. R. Still	R. R. Ferguson E. A. Bennett
CLAY, C. H., Student, Iowa State College, Ames, Iowa.	E. J. Cable (*Non-Member*) J. G. Wyth (*Non-Member*)	E. L. Smith (*Non-Member*) J. F. Clark (*Non-Member*)
FADE, H. R., Architect, Winnipeg, Can.	C. H. Turland J. H. Leonard	D. F. Michie Wm. Glass
GOTSCHALL, H. C., Instructor, New Lane Tech. High School, Chicago, Ill.	John Howatt F. C. Warren	J. H. O'Brien J. J. Finan
HARMONAY, W. L., Mgr., M. J. Harmonay, Yonkers, N. Y.	W. W. Timmis W. K. Walker	R. E. Daly Louis Northon

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
HIGHTOWER, G. B., Engr., James A. Smith Co., Birmingham, Ala.	F. H. Faust N. C. Ebaugh (*Non-Member*)	D. W. McLenegan F. O. Urban (*A.I.E.E.*)
HOULIS, L. D., Chief Engr., Master Baker Oven Mfrs., Cincinnati, Ohio.	W. E. Doty (*Non-Member*) D. G. Jamieson (*Non-Member*)	R. H. Campbell (*Non-Member*) W. V. Kennedy (*Non-Member*)
KNOWLES, W. G., Instructor, Wentworth Inst., Boston, Mass.	C. W. Kimball W. T. Jones	J. W. Brinton W. E. Barnes
LINDBERG, A. F., Asst. Arch. Engr., National Park Service, Omaha, Neb.	F. B. Rowley A. B. Algren	B. J. Robertson (*Non-Member*) F. C. Lang (*Non-Member*)
LINSENMEYER, F. J., Prof. Mech. Engrg., University of Detroit, Detroit, Mich.	W. G. Boales J. F. McIntire	E. E. Dubry G. D. Winans
LYONS, M. A., Htg. Contractor, New York, N. Y.	E. E. Clutter (*A.S.C.E.*) A. E. Straker (*Non-Member*)	A. F. Brassington (*Non-Member*) J. F. Morgan (*Non-Member*)
MACRAE, R. B., Air Cond. Engr., E. J. Nell Co., Manila, P. I.	C. R. Harris (*Non-Member*) L. L. Lewis	J. H. Holton W. A. Grant
MAHON, B. B., Principal, International Correspondence Schools, Scranton, Pa.	S. R. Lewis T. N. Thomson	L. C. Soule W. A. Rowe
PONSELL, F. I., Sales Engr., James P. Ponsell & Sons., Wilmington, Dela.	A. E. Hayman, Jr. R. P. Schoenijahn	H. E. Grossman M. F. Blankin
ROSE, A. A., Sales Engr., Fitzgibbons Boiler Co., White Plains, N. Y.	M. E. Durkee G. E. Olsen	J. A. Darts H. J. Rose
RUEGER, C. A., Jr., Salesman, American Radiator Co., Winston-Salem, N. C.	W. W. Timmis F. B. Campbell	W. R. Zuhlke W. K. Walker
SATCHWILL, F. W., Mgr., Gas Sales, Winnipeg Elec. Co., Winnipeg, Can.	D. F. Michie Wm. Glass	F. B. Thompson (*Non-Member*) J. H. Leonard
SHERMAN, V. L., Assoc. Prof. Mech. Engrg., Lewis Institute, Chicago, Ill.	John Howatt E. P. Heckel	E. T. Murphy C. W. DeLand
SHOTWELL, R. W., Designing Engr., W. J. Spoelstra Co., Inc., Hawthorne, N. J.	W. F. Raymer, Jr. C. W. A. Steinmetz	E. A. Bennett R. R. Ferguson
SPOELSTRA, W. J., Pres., W. J. Spoelstra Co., Inc., Hawthorne, N. J.	W. F. Raymer, Jr. C. W. A. Steinmetz	M. F. Beardsley (*A.S.M.E.*) S. G. Tresouthick (*A.S.M.E.*)
SWANSON, E. C., Research & Design Engr., Andersen Frame Corp., Bayport, Minn.	D. W. Nelson F. B. Rowley	G. L. Larson A. B. Algren
TAYLOR, R. F., Consulting Engr., Dallas, Texas (*Reinstatement*)	F. C. McIntosh A. V. Hutchinson	E. K. Campbell J. H. Kitchen
THOMPSON, FRANK, Chief Draftsman & Engr., Vulcan Iron Works, Ltd., Winnipeg, Can.	C. H. Turland C. D. Kirk	D. F. Michie Wm. Glass
VANDERLIP, P. J., Sales Engr., Oil Heating Co., Lansing, Mich.	R. C. Howland (*Non-Member*) L. F. Snavley (*Non-Member*)	R. R. Seeber A. P. Young (*Non-Member*)
VARNER, J. L., Air Cond. & Comm. Engr., The Jacksonville Refrigeration Co., Inc., Jacksonville, Fla.	H. W. Moore C. B. Gamble	M. J. Stevenson C. E. Lewis
ZIEBER, W. E., Mech. Engr., York Ice Mach. Corp., York, Pa.	I. C. Baker G. E. Tuckerman	L. J. Du Bois W. E. Barnum, Jr.

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

CONNELL, HAROLD, Engr. and Estimator, Norair Engrg. Corp., Newark, N. J.

FATZ, JOSEPH L., Htg. & Vtg. Engr., Board of Education, Chicago, Ill.

ASSOCIATES

CURRIE, F. J., Plbg. and Htg. Contractor, Kirklyn, Upper Darby, Pa.

FRIED, HAROLD V., Air Cond. Engr., Birmingham Elec. Co., Birmingham, Ala.

HOGUE, WILLIAM M., Sales Engr., U. S. Electrical Mfg. Co., Los Angeles, Calif.

JUNIORS

PETERSEN, STANLEY E., Air Cond. Engr., W. A. Ramsay Ltd., Honolulu, Hawaii.

SUNDELL, SAMUEL S., Engr., Larx Company, Minneapolis, Minn. (*Advancement*).

TURNER, PRESCOTT K., Air Cond. Dept., Sawyer Lumber Co., Worcester, Mass.

STUDENT

SMITH, KENNETH M., Student, Michigan State College, E. Lansing, Mich.

MUNICIPAL AUDITORIUM, ST. LOUIS, MO. LE BAUME AND KLEIN, ARCHITECTS; GEO. E. WELLS, INC., CONSULTING ENGINEERS, ST. LOUIS

"Where Large Crowds Gather"

HEALTHFUL, Comfortable conditions must be maintained when large groups of people assemble indoors. Even though every possible means is employed to provide proper ventilation and adequate air conditioning, auditoriums and other gathering places for public use must be kept at just the right temperature and humidity. That is where JOHNSON enters the picture.

An automatic temperature and humidity control system for such important service cannot be "thrown together." Each device must be correlated with every other device with which it is associated. The entire installation must be a complete, unified system.

For instance, among the wide variety of JOHNSON control apparatus there are remote re-adjustable thermostats, re-set automatically by other instruments to maintain always a proper temperature to meet changing conditions. In an auditorium, for example, the "human load" varies, so that the air used for ventilation should be introduced at different temperatures to satisfy varying demands. This is only one illustration of the adaptability of JOHNSON equipment.

In the Saint Louis Auditorium, 379 JOHNSON thermostats, ten distinct types of instruments, operate 165 JOHNSON dampers and more than 500 JOHNSON valves of various types. The entire heating, ventilating, and air conditioning installation is JOHNSON controlled, economically, efficiently, accurately.

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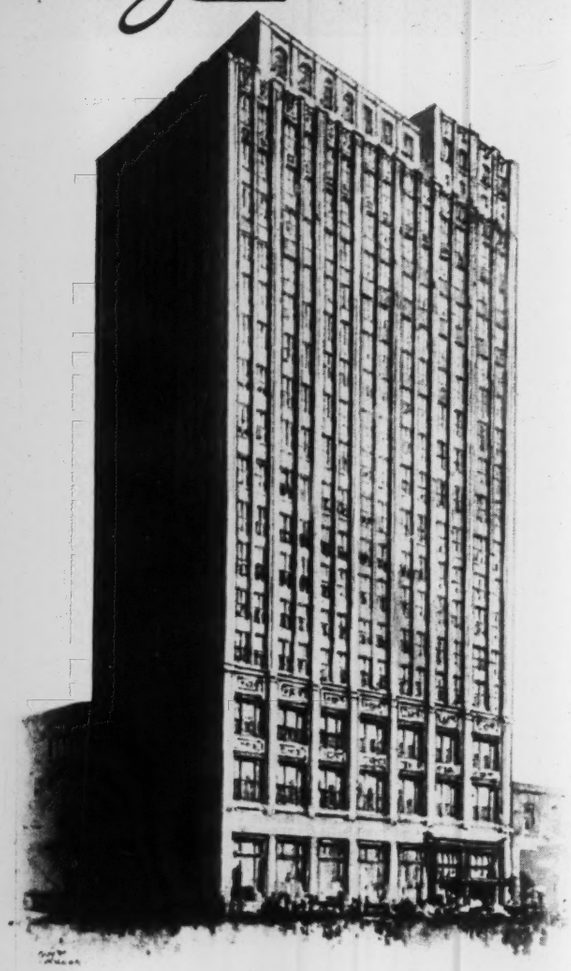

MUNDET CORK INSULATION
adds to the Efficiency of this Air-Conditioned Building

When the Gulf States Building of Dallas, Texas, was air-conditioned throughout its 16 floors, the specifications called for CORK INSULATION . . . . furnished and installed exclusively by Mundet.

Nearly two miles of Mundet Moulded Cork Pipe Covering were used to assure a permanently efficient temperature control system.

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Mundet Cork Products are made of 100% pure Cork. Mundet Cork doesn't wear out, settle or warp. Its services remain unimpaired year after year. Write for information on its many advantages.

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Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 95 . . . Add the new products and companies listed here to your Directory Section which you received in your January 1935 Heating, Piping and Air Conditioning and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed.

For Balancing One Pipe Steam Systems

No. 355—New "Six-speed" adjustable venting port, incorporated in "Hoffman" air and vacuum radiator valves, permits varying the speed of venting and enables balancing steam circulation to radiators of one pipe steam heating systems.

By varying the rate of venting the air from a one pipe steam radiator, the flow of steam into the radiator can be controlled. The amount of air contained in a radiator is proportional to its heating surface and by means of the adjustable vent ports, the venting of large radiators can be accelerated and the venting of smaller radiators reduced, so that in a given period of time, the same proportion of each radiator will be heated. This means of control is particularly valuable in a one pipe steam system with oil or gas fired boilers, says the manufacturer. The venting of the radiators in the room where the thermostat is located can be retarded and the venting of the more remote radiators accelerated to insure their receiving their quota of steam during each period of burner operation. Retarded venting is usually desirable and at times imperative in radiators of the convector type, because of their relatively small air content.

The top cap of the device is a shutter containing six ports of varying sizes, which permit a wide range of venting capacity. The ports are visible and the contractor can quickly select and set the desired port.—Hoffman Specialty Co., Waterbury, Conn.

Small Steam Trap, 0-400 lb

No. 356—New "Yarway" impulse steam trap is made in six sizes, ½ to 2 in., and is little larger than a pipe union, the ½ in. size weighing 1⅛ lb. Body is cold rolled steel, working parts hard monel, bonnet and cap brass. Each trap is factory set to operate at all pressures from 0 to 400 lb.

Operation depends on the difference in flow characteristics of cold water, hot water and live steam, flowing through two orifices with a chamber between. Movement of the one moving part, the valve disc, is governed by pressure variations in the space above valve piston called the control chamber, these changes in pressure occurring with changes in temperature of condensate ranging from cold water to water at steam temperature. When handling cold water, the pressure under valve piston (inlet side of trap) is greater than the reduced pressure in control chamber above piston—clearance between piston and cylinder acting as first orifice—and valve opens to allow free discharge of condensate. As the accumulation of cold condensate disappears the remaining condensate approaches steam temperature, flashing takes place in control orifice in center of valve disc, the flow is choked and the pressure in control chamber builds up to close valve. Valve disc, piston and center orifice are accurately proportioned to give positive opening of valve when cold condensate collects and quick closing when pipe system is hot and there is no condensate or the condensate is at or near steam temperature.—Yarnall-Waring Co., 102 E. Mermaid Lane, Chestnut Hill, Philadelphia, Pa.

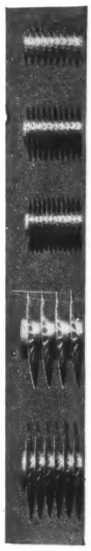
Sound Absorbing Duct Lining

No. 357—New "Air-Acoustic Sheets," designed to reduce or eliminate noise transmitted through ducts are a rock wool sound absorbing material in rigid block form and a suitable binder and are primarily used as duct lining.

AEROFIN

HEATING
AND
COOLING SURFACE

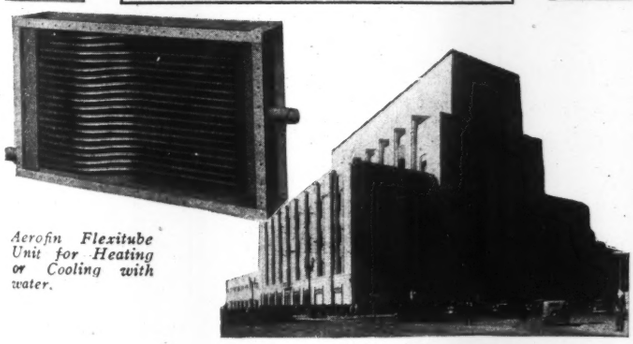
SPECIFY AEROFIN FOR HIGHEST EFFICIENCY



Aerofin Standardized Light Weight Fan System heat exchange surface is the first choice of architects, engineers and building owners for Heating or Cooling because of its proved superiority. Progressive heating and cooling contractors install it because it gives complete satisfaction.

Aerofin is years in advance of ordinary heating and cooling surface because of its exclusive features. It is available in aluminum, copper or other special metals. Whatever you have wished for in a fan system surface you will find in Aerofin.

The home office in Newark or any of our branch offices will gladly send complete descriptive literature or render prompt, personal and efficient technical cooperation. Simply write to the address below.



Aerofin Flexitube Unit for Heating or Cooling with water.

Aerofin surface is installed in the Los Angeles Times Building. Gordon B. Kaufmann, Architect. P. J. Walker Company, Building Contractors. Carrier Engineering Corporation, Air Conditioning Contractors.

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SARCO
Radiator Traps and Packless Inlet Valves In Florida

ANOTHER monument to the good judgment and ability of Wm. B. Ittner, M. Leo Elliott, Associate Architects, is the St. Petersburg (Fla.) High school illustrated, which is equipped with Sarco Radiator Traps and Inlet Valves.

That in schools, too, Sarco heating equipment has been found most efficient is shown by the fact that in New York City Sarco Heating Systems went into all but two of the schools included in a $20,273,521 budget; that in Savannah (Ga.) every school erected in four years was Sarco equipped, and that a large percentage of the better schools in most cities have adopted "Sarco" as the standard.

A dependable product is never the result of guess work—it is invariably made by someone who knows how. Which is why "Sarco" is a name that ends all questions about quality and dependable performance.

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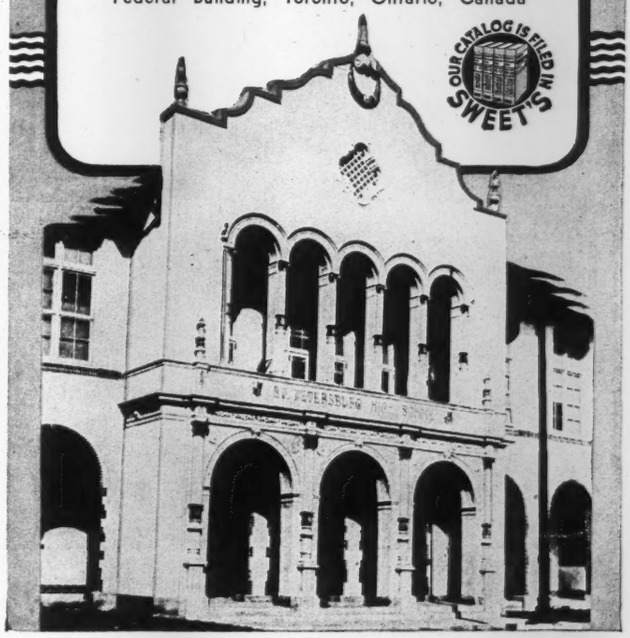


They will not smoulder or support combustion, states the maker, are highly moisture resistant, have good sound absorbing efficiency, and low thermal conductivity so that they also serve as heat and cold insulation. Attached to duct surfaces by spot cementing with acoustical cement or by mechanical fastenings.—Johns-Manville, 22 E. 40th St., New York, N. Y.

Improved Pipe Wrench

No. 358—Improved pipe wrench has a renewable lower jaw of hardened steel, with cross tongues seating into cross slots in the handle, which is locked in place to eliminate backward shear on its pin and prevent loosening in service. However, the jaw can be easily renewed when required. A new type of spring, said to have longer life and easier action, when necessary may be replaced without the use of tools. Other features include comfortable hand-grip, large capacity in the popular 10-in. size, reduced weight and narrower jaws in the 24 in. size, a Parkerized rust-proof finish and a cadmium plated nut.

The wrench is of drop forged steel with its housing forged integral with the handle, heat treated for maximum strength.—Walworth Co., 60 E. 42nd St., New York, N. Y.

Variable Pitch Sheave for V-Belts

No. 359—New development in power transmission is known as the "Vari-Pitch Texrope" sheave. By means of a simple adjustment the pitch diameter can be changed to give variations in speed as high as 15 to 25 per cent per sheave. If both sheaves of a drive are of this type the range of variation can be doubled.

The sheaves are made in two multi-groove types, stationary and motion controlled, the first type recommended for applications that require occasional change of speed and the second for applications that require frequent quick changes within the full range while the drive is in operation.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Rubber Putty Solves A. C. Problem

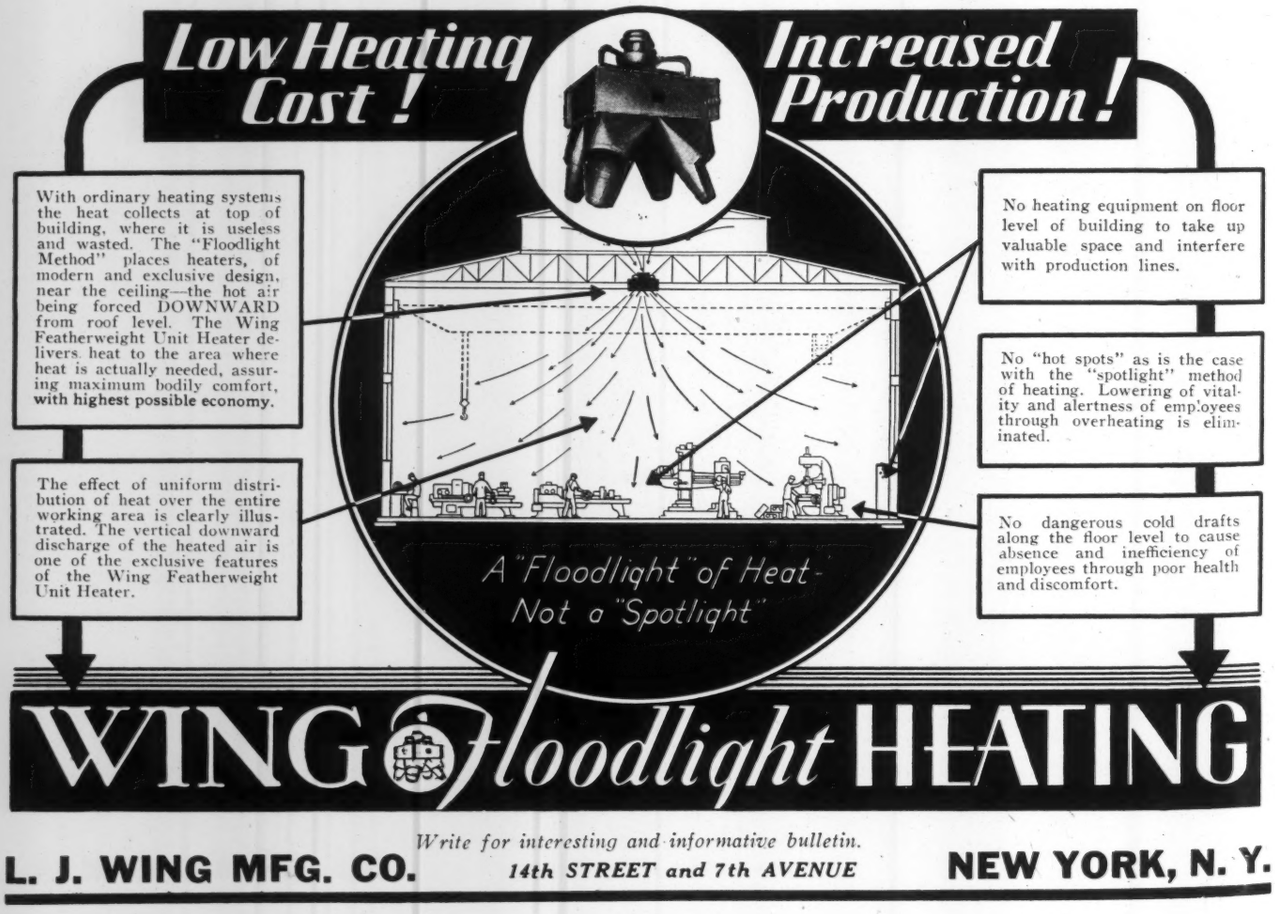
No. 360—New rubber putty ("Plastikon") which is resistant to moisture, corrosive chemicals and fumes, appears to be the solution to the problem of properly sealing windows against air leakage in air conditioned buildings, states the manufacturer, who cites the problem faced by the Onandaga Pottery Co., Syracuse, N. Y. Because the special paper used in lithographing the many colored transfer designs to go on pottery must be kept in the same condition at all times to prevent curling or shrinking, the printing department is housed in a structure insulated with thick cork, has double glass windows, and is equipped with an air conditioning system to maintain a year round temperature of 72 F. The windows were sealed with an ordinary putty which soon dried out, cracked and broke away, presenting a continuous maintenance problem because the air leaks which developed made it difficult to maintain the constant temperature desired.

The new putty which solved the problem is similar in appearance and consistency to ordinary painters' putty and may be applied with a knife in the same manner. It adheres equally well to steel or wood surfaces and because it contains little oil, requires no mixing, says the maker.—B. F. Goodrich Co., Akron, Ohio.

Improved Window Filter Unit

No. 361—The "Model 40-A Airgard" recently announced, fourth in a line of window filter units, combines features for year round service. Positive "finger-tip" damper control makes it possible to regulate the volume of incoming air to the exact amount required.

Cabinet of the unit is wood finished in natural walnut or ivory. The air filter is a special replaceable "Airmat Drifilter" containing 14 sq ft of filtering surface to assure long life. Standard 6-ply paper is used in the filter, which is guaranteed to


Low Heating Cost!
Increased Production!
With ordinary heating systems the heat collects at top of building, where it is useless and wasted. The "Floodlight Method" places heaters, of modern and exclusive design, near the ceiling—the hot air being forced DOWNWARD from roof level. The Wing Featherweight Unit Heater delivers heat to the area where heat is actually needed, assuring maximum bodily comfort, with highest possible economy.
The effect of uniform distribution of heat over the entire working area is clearly illustrated. The vertical downward discharge of the heated air is one of the exclusive features of the Wing Featherweight Unit Heater.
No heating equipment on floor level of building to take up valuable space and interfere with production lines.
No "hot spots" as is the case with the "spotlight" method of heating. Lowering of vitality and alertness of employees through overheating is eliminated.
No dangerous cold drafts along the floor level to cause absence and inefficiency of employees through poor health and discomfort.
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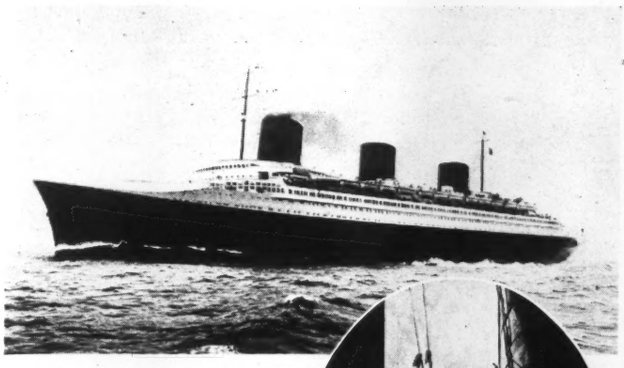
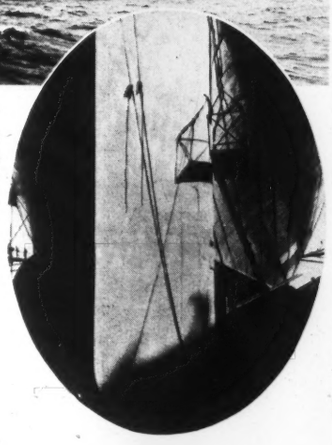
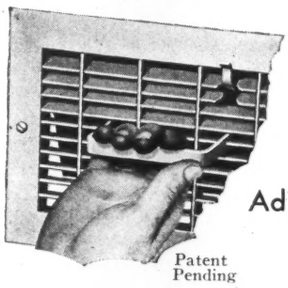


The French Line's "Normandie" . . . . the world's largest is at the same time the world's most manoeuvrable liner. Her "3 stories tall" rudder of radical design sends her in any direction with certainty.



In ANY Direction . . . with Certainty



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Adjustable Directed Air Flow Registers and Grilles

CONSIDER the Normandie. Without the rudder to give direction to the velocity created by her 160,000 H. P. engines, she would be helpless.

Likewise, mere air velocity does not constitute air conditioning. Air flow must be given direction, accurately.

The grille bars of Independent "Fabrikated" *Adjustable* Directed Air Flow Registers and Grilles can be set at any angle to 45 degrees to direct air flows accurately, up or down, right or left, with certainty. Adjustments can be made after the grilles are installed if desired.

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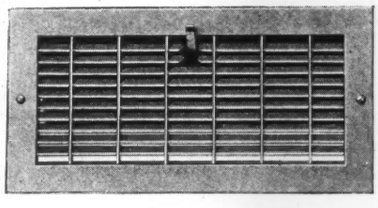

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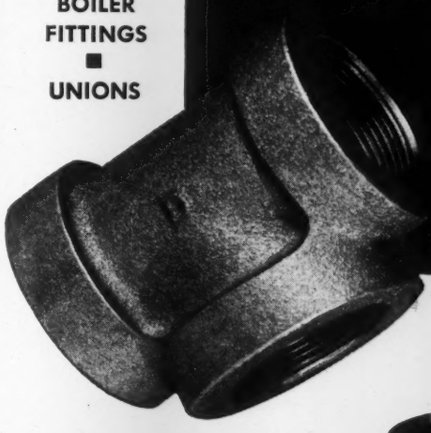

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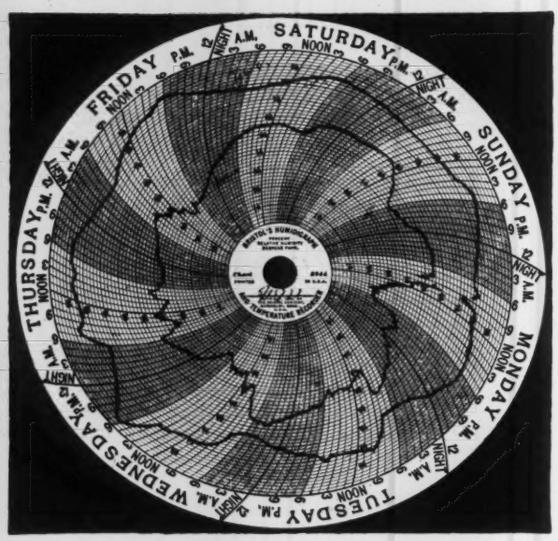

Typical chart made by Bristol's Thermo-Humidigraph in the plant of a certain firm of manufacturing chemists. Outer curve is temperature; inner curve is relative humidity.

IF you are having trouble in upholding product quality, are you sure that the conditions under which processing is done are not at fault? Do you know?

There is no need or excuse for guessing. If for example your product is sensitive to atmospheric temperature and humidity, the thing to do is to install a handy portable Bristol's Thermo-Humidigraph and see every moment of the day and night just what the temperature or humidity really is. Also how these are fluctuating.

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Bristol's Portable Thermo-Humidigraph, Model 4069. Eight inch chart, one revolution in 7 days. For permanent wall mounting, specify Model 4068.

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have an efficiency of 97 per cent in dust removal. Hinged cover provides for recirculation of indoor air and the 45 deg "Uniflo" outlet grille may be turned to any one of four positions to control the direction of discharge and prevent drafts. The unit does not cool the air nor affect the humidity; some cooling effect is obtained by the air movement and it may be operated at night to bring in cooler outside air, but its primary purpose is to provide clean, filtered air for ventilation or for the relief of hay fever and pollen asthma.—American Air Filter Co., 107 Central Ave., Louisville, Ky.

Self-Contained Room Conditioner

No. 362—Self-contained ½ ton, 275 cfm room cooling unit (Type FC-2) operates without using special power lines or water supply and drain piping. Its four motors (one fan, three compressor) start in staggered sequence to avoid heavy inrush of starting current, with consequent danger of blowing fuses. Unit is air-cooled so no water connections are necessary. Drain connections are eliminated as the water condensed on the cooling coils is evaporated into the condenser cooling air and blown outside.

Basic element of this unit is a compressor unit consisting of a hermetically sealed compressor similar to that used in the "Monitor-Top" refrigerator. In the same framework which holds the compressor is mounted the evaporator, or cooling coil, and, just above the compressor, the air-cooled condenser. All refrigerant connections to the evaporator and condenser, including the expansion valve and heat interchanger, are made at the factory, and the necessary charge of freon and oil is sealed in at the factory. There are three of these compressor units mounted in a frame at the lower part of the cabinet.

Upper part of the cabinet houses fans, filters, control switches and window duct connection. A single motor drives the two sets of fans, one to recirculate air from the room, bring in outdoor air, send the mixed air through filters, over the evaporator coils to cool and dehumidify it, and then out into the room, the other to bring in outdoor air, filter it, pass it over the condenser coils and the drip pan which collects condensate from the evaporators, and send the heated, moisture-laden air outdoors. In filtering the condenser cooling air before it flows over the coils, maintenance requirements are reduced, for otherwise the fins on the condenser coils would clog with dirt, the motors would be overloaded and the cooling capacity reduced.

All parts of this unit are housed in an attractive cabinet. Control is manual, interlocked to prevent incorrect operation.—General Electric Co., Air Conditioning Dept., Bloomfield, N. J.

New Steam Trap

No. 363—Entire working mechanism of new combination float and thermostatic steam trap is mounted on the cover, with all piping connections on the body. The cover and working mechanism may be removed for inspection and cleaning without disturbing the piping connections. Other features are reversible valve and seat, of stainless alloy steel; if valve and seat show signs of wear, they may be reversed in a few minutes.

The "Adsco" vertical steam trap is a continuous flow type. A deep water seal prevents loss of steam. A limit stop on the float lever prevents the elevation of the float beyond normal to avoid a sudden rush of condensate damaging the float by contact with the body. Furnished in six capacities at given pressures. Two of the models are arranged for either vertical or 90 deg inlet connections, while the third is provided for horizontal inlet and outlet connections from either side.

The smallest trap, weighing a little over 5 lb, is well adapted for installation with concealed and indirect radiation, says the maker, as it fits well within the small recess allotted to invisible radiation, and its vertical inlet and outlet connections on the same center line allow it to be revolved to any convenient position where the cover can be removed for inspection.—American-District Steam Co., North Tonawanda, N. Y.

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The Taylor Forge Line of Seamless Steel Welding Fittings not only offers correctly engineered welding fittings of unvarying quality—it also offers every type, style, size, and thickness of fitting that is usually required.

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All Taylor Weldells are reinforced at points where stress is known to be greater than in the run of the pipe. In Taylor Weldells this means added thickness at the crotch, where strain is greatest; in Taylor Tees this means added thickness in the intersection, and so on throughout the entire line of welding fittings.

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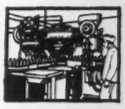
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New Cast-Machined Pulleys

No. 364—New line of "Day-Steel" pulleys of cast-machined (semi-steel) construction, for use in conjunction with "Dayton Cog-Belt" drive for all ratings up to 15 hp has been announced. Pulleys are so formed as to be of maximum strength with elimination of excess metal, thereby providing cast-machined pulleys of approximately the same weight as pressed steel pulleys, says the maker. All finished surfaces are machined to accurate limits of precision work, the special semi-steel providing a smooth and close grained groove surface. Pulleys are balanced to insure a true-running drive.

The company will continue to offer pressed steel type pulleys with the same diameters as the cast-machined type.—Dayton Rubber Mfg. Co., 2345 W. Riverview Ave., Dayton, Ohio.

Condensation Return Units

No. 365—Automatic "Monobloc" condensate return units recently announced are applicable to a wide variety of condensate return services—steam heating systems in hotels, apartment houses, theaters, office buildings, factories, greenhouses, and for steam process plants, as in laundries, chemical plants, cleaning and dyeing plants; and in connection with cooking equipment, kilns, dryers, etc. Ratings range from 2,000 to 40,000 sq ft of direct C.I. radiation or equivalent, the maximum space requirements of the 2,000 size being 21" x 32" x 28" high, and of the 40,000 size, 24" x 57" x 38" high. Condensate flows by gravity into the storage tank, trips a float switch at a predetermined depth, and the motor is automatically started. When the tank is drawn down to a predetermined minimum level, the motor is automatically stopped. Pump capacities for the 54 sizes range from 3 to 60 gpm; storage tank capacities from 22 to 98 gals; and discharge pressures vary from 10 to 40 lb per sq in.

Each unit includes bronze-fitted centrifugal pump, single or multi-stage, with splash-proof motor; float switch; starter where required; piping; tank; and gage glass; all mounted on a steel base plate. Duplex units include two float switches and two pumps mounted on opposite sides of the tank. Three standard types of a-c or d-c motors are included.—Worthington Pump and Machinery Corp., Harrison, N. J.

New Globe Valve

No. 366—New union bonnet bronze globe valve has a number of features, including superhard stainless steel valve discs and seat rings (hardened to 500 Brinell), which are said to prevent wire drawing, steam cutting and galling. Disc is attached to stem in a new way that insures correct seating and facilitates regrinding, and special types of bronze have been developed for the valve stem and bonnet which the makers state lengthen the service life of this valve.

Design provides tight back-seating and permits easy repacking while valve is in pressure service. Made for steam pressures up to 300 lb, these new bronze valves are available in both globe and angle patterns.—The Hancock Valve Co., 27 Elias St., Bridgeport, Conn.

Relative Humidity, Temperature Recorder

No. 367—Recently announced "Hythergraph" gives simultaneous records of relative humidity by means of multiple human hair element, and of dry bulb temperature by means of a special bi-metallic element, on common time lines. The instrument is offered for weekly records, an 8 day clock being provided. A progressive record is given on a rectangular chart for easy reading.

The instrument has been designed primarily for permanent installation in connection with air conditioning installations in department stores, theaters, restaurants, hotels, or industrial work. Without extra cost, it is offered with carrying handle. The case is furnished with lock and means for securing in position. A year's supply of charts is included.—Julien P. Friez & Sons, Inc., 4 N. Central Ave., Baltimore, Md.

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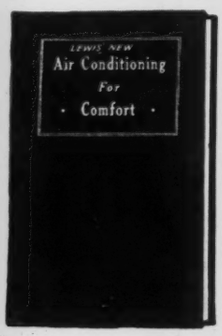

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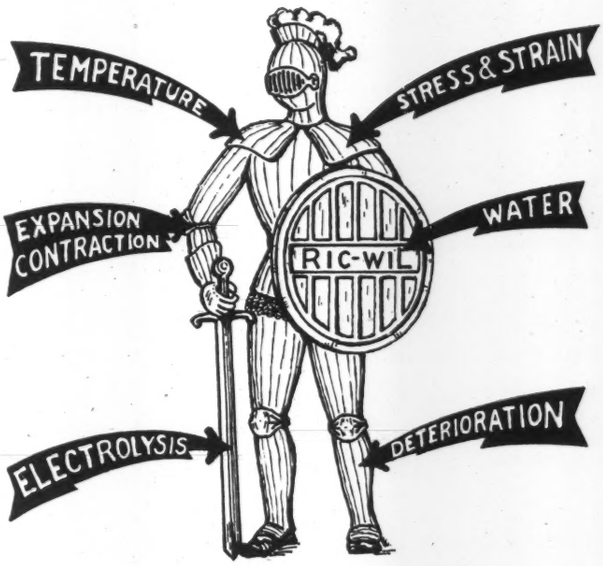

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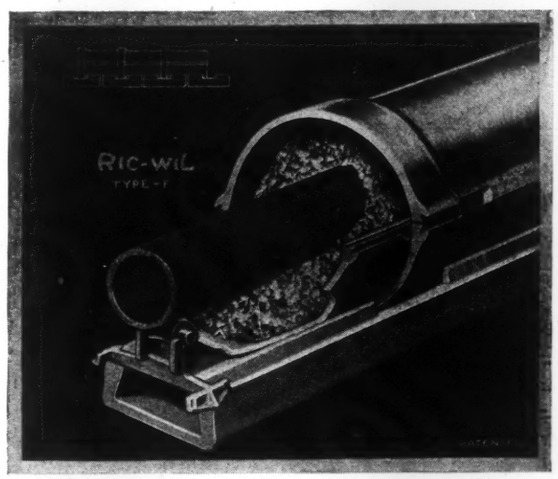

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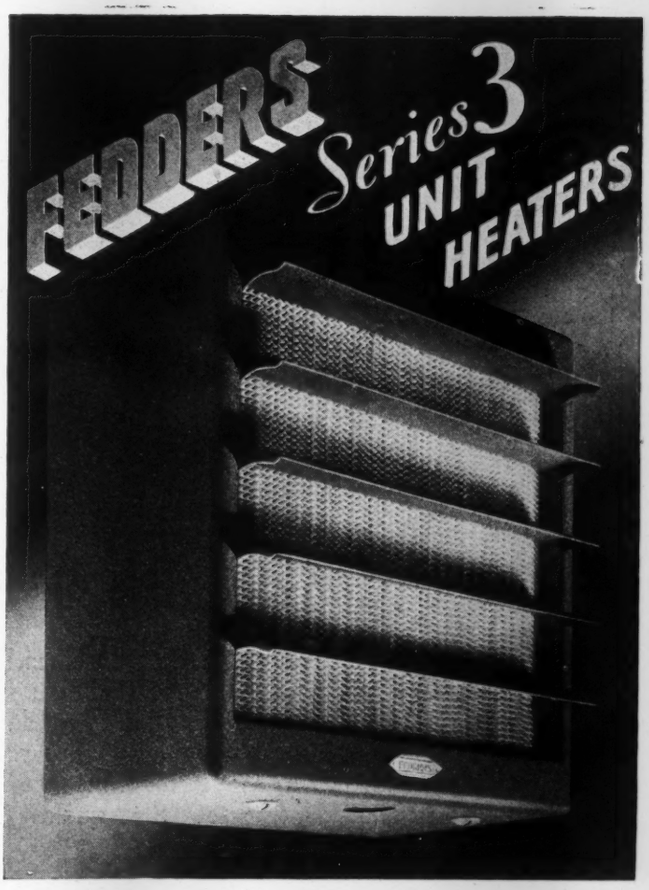

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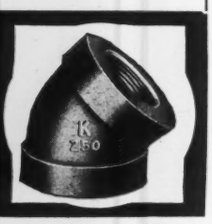

New Air Operated Controllers

No. 368—New and complete line of recording and indicating air operated controllers for temperature, flow, pressure and liquid level includes the "Air-o-Line," a controller with 1 to 150 percent throttling range and automatic reset. This control system recognizes and corrects for the magnitude, rate and direction of departure from the control point. Throttling range and automatic reset dials are instantly adjustable with a screw driver, without removing the chart plate, states the maker.

Indicating and recording thermometer-type temperature controllers are available for temperatures within limits of —40 F and +1200 F; potentiometer-type controllers for temperatures within limits of —300 F and +3400 F.

Two types of flow controllers and liquid level controllers are included; the inductance bridge and the mechanical type. Thus the remote operating characteristics of the electric flow meter and the flexibility of air operated control are combined in one controller.

Indicating and recording pressure controllers are available in ranges from 30 in. vacuum to 3000 lb per sq in.

Three other types of air operated controllers are included in the new line. These are the "Full Throttler," a controller with 1 to 150 percent throttling range and manual reset; the "Throttler," a controller with 1 to 10 percent throttling range and manual reset; and the "On-Off Controller," for two-position service.—Brown Instrument Company, Wayne and Roberts Ave., Philadelphia, Pa.

75 Ampere Arc Welder

No. 369—New 75 ampere arc welder, recently announced, especially designed for light gauge welding, has welding range of 15 to 125 amperes in three steps and performs exceptionally well on 24 ga and heavier, using $\frac{1}{16}$, $\frac{3}{32}$ or $\frac{1}{8}$ in. electrodes, either bare or coated, states the maker. It is powered by a 3 hp motor, comes completely equipped with starting switch, polarity change switch, dual remote control, double reading voltmeter and double reading ammeter. Provided with convenient lifting eye on top and in the portable type is bolted to welded steel truck with four steel disc wheels and drawbar; easily demountable from truck when desired, the reactance unit being enclosed in pressed steel "Turret Top."—Hobart Brothers Co., Box HT95, Troy, Ohio.

Vibration Isolation Platforms

No. 370—An effective means of eliminating or reducing rumblings and other noises induced by vibrating machinery has been devised through the use of vibration isolation platforms. In the design of a vibration isolating construction, care must be taken that its natural frequency of vibration is well below the natural frequency of vibration of the machine itself.

To accomplish this purpose, "J-M" vibration isolation platforms are made of two or more tiers of stringers, placed at right angles, and supported and separated from each other by vibration-absorbing chairs. These chairs are U-shaped pieces of metal and felt which fit the stringers. A platform top is secured to the upper tier of stringers and the machine fastened to it. A loose rock wool fill occupies the space between the floor and the top of the platform, and is held in place by an apron or skirting.

The presence of heavy felt in the chairs lends the necessary resiliency to the platform. The chair spacing, with consequent variable loading, makes possible the design of platforms which will isolate practically any frequency of vibration, says the maker.—Johns-Manville, 22 E. 40th St., New York, N. Y.

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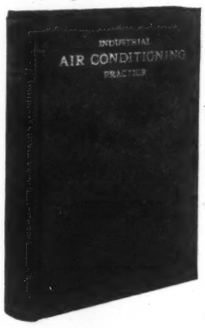

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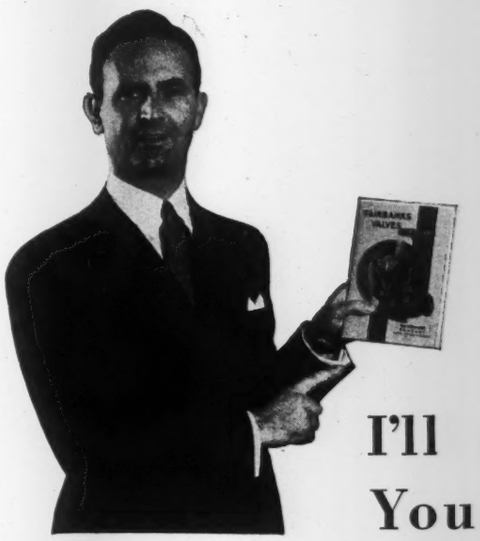

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Book Reviews

Code for Pressure Piping

"Code for Pressure Piping (Power, Gas and Air, Oil, District Heating)," American Tentative Standard B31-1-35. Approved by American Standards Association June, 1935. Sponsor body, American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y. 164 pp. 5¼x7¾ in., paper bound. Price, $1.00.

The foreword briefly reviews the history of the pressure piping code, and the introduction describes its purpose and intent, cooperation of the committee with industry, and the application of the code in industries where piping is used.

Following are the six sections of the Code: Section 1, Power Piping Systems; Section 2, Gas and Air Piping Systems; Section 3, Oil Piping Systems; Section 4, District Heating Piping Systems; Section 5, Fabrication Details; Section 6, Materials—Their Specifications and Identification. An appendix covers a suggested marking system for fittings and valves, as the system was proposed subsequent to the letter ballot on the code. A listing of the personnel of the code committee is included, and a most complete cross-index facilitates the book's use.

The code itself was reviewed in detail in a series by Sabin Crocker published in HEATING, PIPING AND AIR CONDITIONING during 1934.

Psychrometric Tables and Notes

"Psychrometric Notes and Tables," by Elmer Torok, Superintendent of Power, North American Rayon Corp. Published by North American Rayon Corp., 261 Fifth Ave., New York, N. Y. 89 pp., 5x7 in., flexible binding. Price $2.00.

This helpful book combines a great deal of psychrometric information, presenting it in a manner which makes it easily available for the solution of psychrometric and air conditioning problems.

The first of the four main sections into which it is divided defines psychrometric terms in question and answer form. The second part comprises six tables: relative humidity as determined by wet and dry bulb temperature; dew-point from relative humidity and dry bulb temperature; dew-point from wet and dry bulb temperature; vapor pressure from wet and dry bulb temperature; absolute humidity from relative humidity and dry bulb temperature; and mixtures of air and saturated water vapor.

The third section is devoted to examples of the solution of psychrometric problems with these tables, and the book concludes with a section containing a great deal of pertinent miscellaneous data.

New Edition of "Corrosion"

"Corrosion, Causes and Prevention," by Frank N. Speller. 2nd edition, 1935. 694 + xiii pp., 6x9 in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. $7.00.

The second edition of this standard work on corrosion (the first edition of which was published in 1926) reviews the important developments of the past nine years in corrosion and its prevention, particularly with reference to iron and steel. The author points out in his preface that since the appearance of the first edition, some 3,000 articles on corrosion of metals have been published, and that many more and better data bearing on the problem are now available with respect to both the influence of various factors and preventive means. In many cases,

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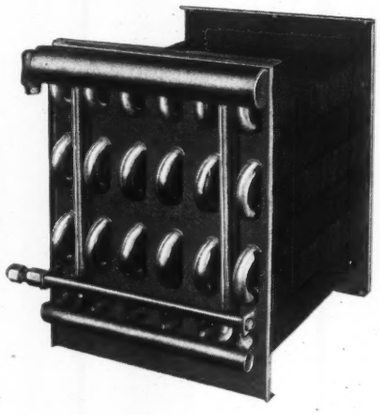

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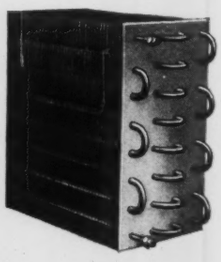

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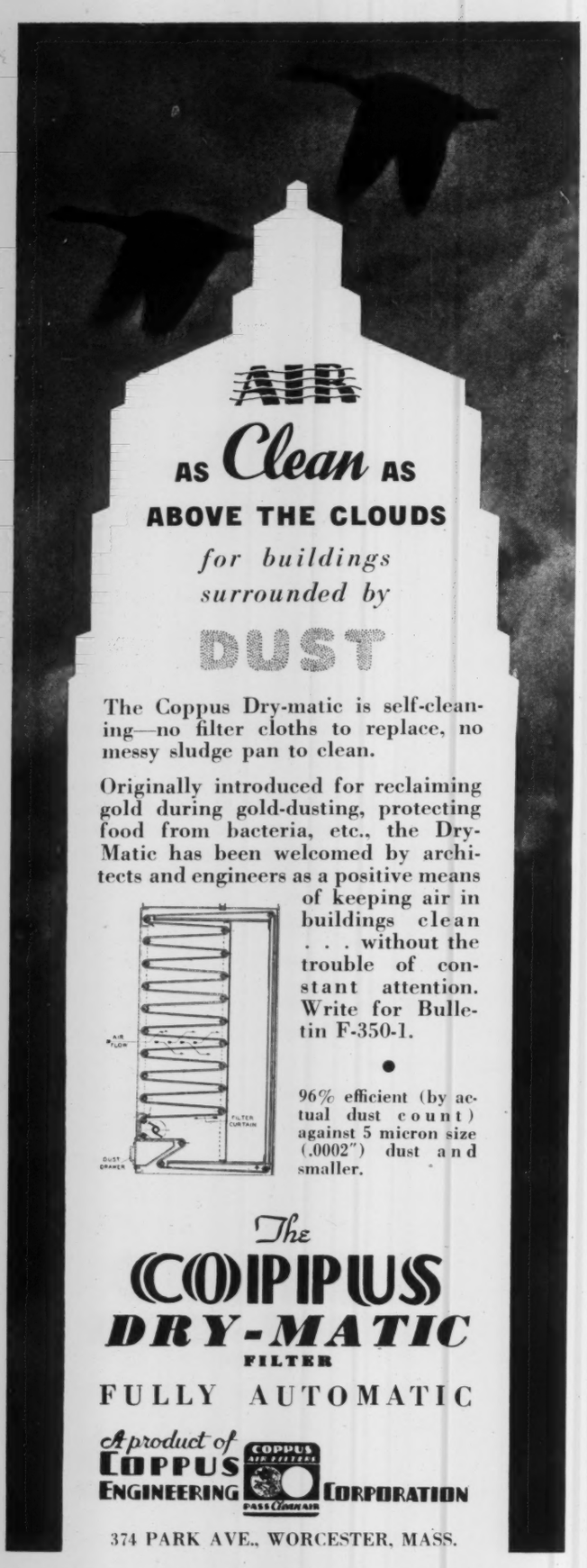
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the older sections of the book have been condensed or omitted where better data are now available, so that the earlier work is still useful as a reference on certain subjects.

The book is divided into two parts, Part 1 covering general principles and including an introductory outline of the corrosion problem, and chapters on nature and mechanism of corrosion, influence of methods of manufacture and treatment, influence of factors internal to the metal, influence of factors external to the metal, principles and methods of corrosion testing, and relative corrosion of ferrous metals. Part 2 is concerned with preventive measures, including prevention of corrosion in the atmosphere, underwater, in closed water systems by removal of dissolved gases, in high pressure steam plants—boiler water treatment, in steam and hot water heating systems, in the chemical industries, and underground. The final chapter is devoted to stray current electrolysis.

In addition to the 15 chapters, there is a 16-page appendix, and a selected bibliography of 27 pages. Both an author and a subject cross-index are given.

Booklets, Reports and Papers

Booklet on Lead Pipe

"Lead Pipe," published by Lead Industries Association, 420 Lexington Ave., New York, N. Y. 2nd edition. 24 pp., 8½x11 in.

This illustrated booklet describes how lead pipe is made, the grades of lead pipe, discusses joints and the burning or welding of lead, calking lead, and considers the use of lead piping for handling corrosive chemicals, and in plumbing and other work. Tables of sizes and weights and other useful data are incorporated.

Control of Corrosion

"The Control of Corrosion in Air Conditioning Equipment by Chemical Methods," by C. M. Sterne, Chief Engineer, Metropolitan Refining Co., Inc., Long Island City, N. Y., reprint of a paper presented at the 38th annual meeting of the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. 10 pp., 6x9 in.

The author introduces his subject by pointing out that with increasing use of air conditioning, consideration of the corrosion problem is most timely. A central station type of system is then briefly described, the corrosion exposures of such a system are listed, and the characteristics of the recirculated water affecting the corrosion rate are outlined.

The author then describes representative tests of corrosion of air conditioning systems, selected from studies of some 200 different comfort and industrial installations. He concludes that check examinations of these systems have shown that by proper chemical treatment and supervision, corrosion attack may be reduced to a minimum.

Asbestos Dust

"Effects on Inhalation of Asbestos Dust on the Lungs of Asbestos Workers," by A. J. Lanza, Assistant Medical Director; William J. McConnell, Assistant Medical Director, and J. William Fehnel, Chemist, Metropolitan Life Insurance Co. Reprint No. 1665 from Public Health Reports, 12 pp. 6x9 in. Available from Superintendent of Documents, Washington, D. C. Price, 5c.

This report describes methods of making dust studies and reports conditions found in plants investigated, considers briefly dust control, physical examinations, and analyzes insurance claims. In the conclusions it is stated that it is not practicable as yet to establish standards for the asbestos dust content of air, but that the amount of dust in air in the plants studied can be substantially reduced.

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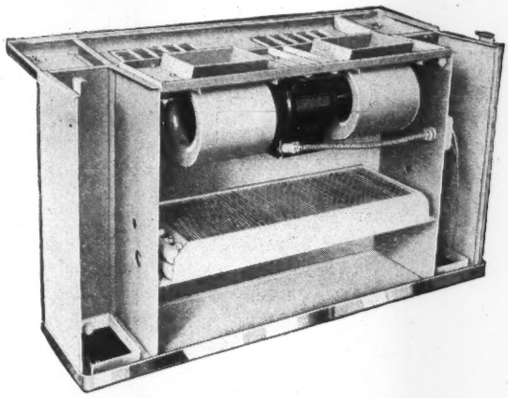

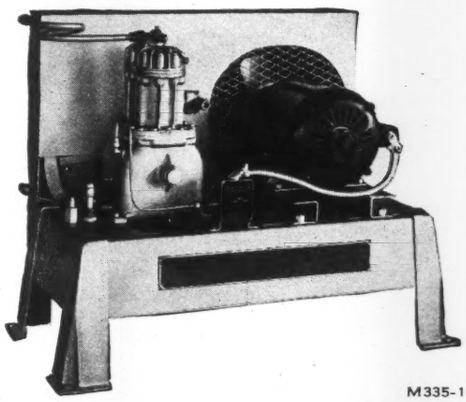

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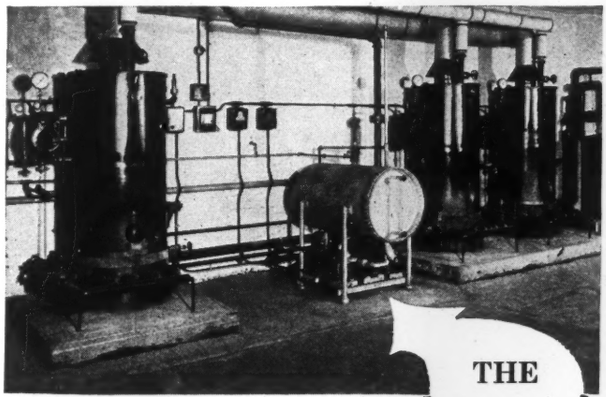

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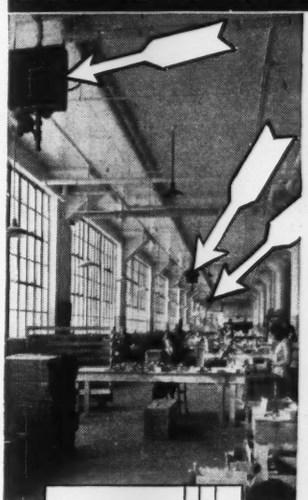

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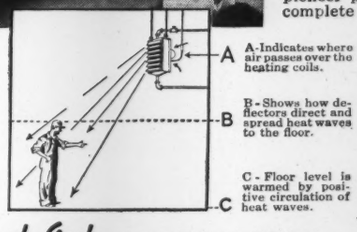
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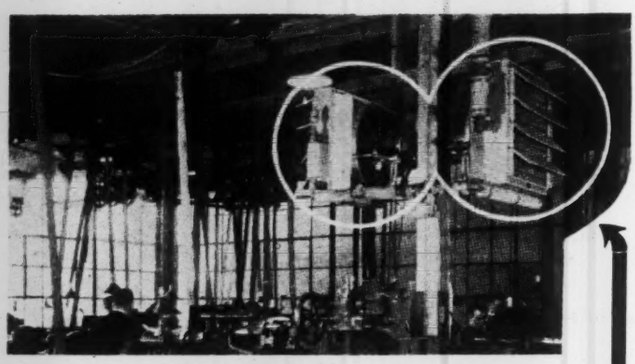

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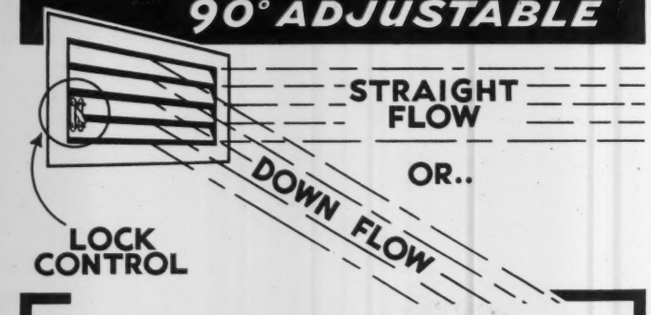

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American Welding Society: Fall meeting, Chicago, Ill. Sept. 30. Secretary, W. Spraragen, 29 W. 39th St., New York, N. Y.

Midwest Power Show: October 14-18, Chicago, Ill. G. E. Pfisterer, Managing Director, 1 N. LaSalle St., Chicago, Ill.

American Gas Association: Annual convention, October 14-18, Atlantic City, N. J.

American Public Health Association: Annual meeting, Oct. 7-10, Milwaukee, Wis. Headquarters Office, 50 W. 50th St., New York, N. Y.

International Acetylene Association: Annual convention, Nov. 12-15, Cleveland Hotel, Cleveland, Ohio. Secretary, H. F. Reinhard, 30 E. 42nd St., New York, N. Y.

International Heating & Ventilating Exposition: January 27-31, International Amphitheater, Chicago, Ill. Manager, Charles F. Roth, Grand Central Palace, New York, N. Y.

American Society of Heating and Ventilating Engineers: Annual meeting, January 27-31, Palmer House Hotel, Chicago, Ill. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

National Warm Air Heating and Air Conditioning Association: Winter meeting, January 27-29, Hotel Stevens, Chicago, Ill. Managing Director, A. W. Williams, A. I. U. Bldg., Columbus, Ohio.

Recent Trade Literature

For your convenience in obtaining copies of bulletins, see coupon on page 95.

No. 538. AIR COMPRESSORS: Pennsylvania Pump & Compressor Co., Easton, Pa. 16 p. bulletin on single stage, double acting horizontal, roller bearing air or gas compressors, furnished for both power and steam drive, 5 to 125 hp, pressures 12 to 150 lb.

No. 539. AIR COMPRESSORS: Worthington Pump & Machinery Corp., Harrison, N. J. Four 4 p. bulletins on portable air compressors in four sizes (105, 160, 210, and 315 cfm actual air); various types of mountings.

No. 540. AIR CONDITIONERS: York Ice Machinery Corp., York, Pa. Data sheet for industrial coil type unit air conditioners, four models.

No. 541. AIR CONDITIONING: Airtemp, Inc., Chrysler Bldg., New York, N. Y. Loose-leaf booklet with numerous illustrations describing and giving technical data on compressors, air conditioning units, and circulating water, central duct, direct expansion, individual unit, ice bunker, and well water air conditioning systems.

No. 542. AIR CONDITIONING: Frigidaire Corp., Dayton, Ohio. 16 p. booklet "A Guide for Those Who Contemplate Air Conditioning" listing and discussing the factors to be considered in the selection of a system.

No. 543. AIR CONDITIONING: Trane Co., 303 S. 11th St., LaCrosse, Wis. 16 p. booklet "A Discussion of the By-Pass in Modern Air Conditioning," including sections on relative humidity and moisture content, temperature, draft prevention, temperature control, refrigeration power costs, refrigeration tonnage, and comfort.

No. 544. AIR HEATERS: J. O. Ross Engrg. Corp., 350 Madison Ave., New York, N. Y. 16 p. catalog of air heaters for industrial processing uses, describing various types of equipment, operation, and including general pertinent data.

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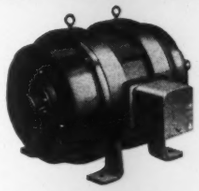
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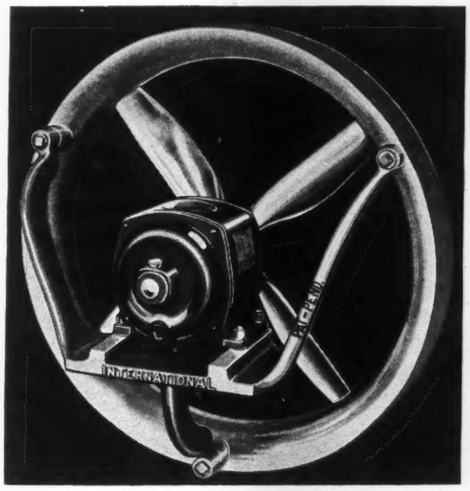

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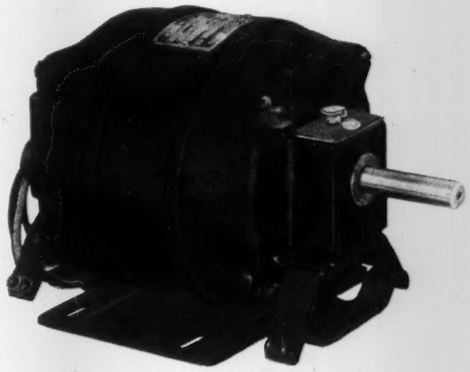

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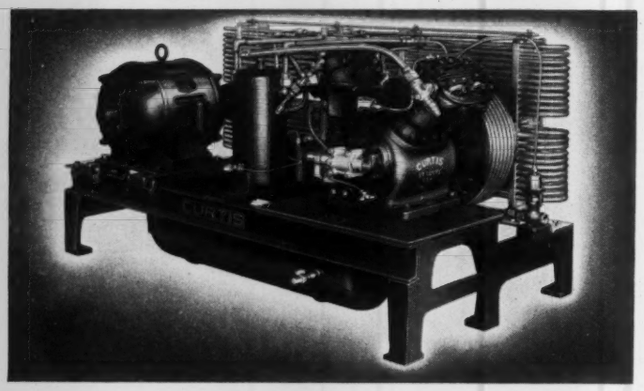

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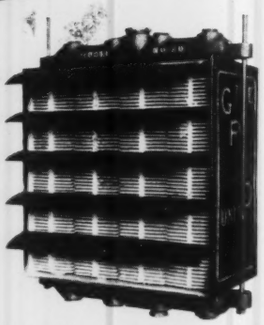

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No. 547. ANCHORS: Rawlplug Co., 98 Lafayette St., New York, N. Y. 8 p. booklet describing construction, use, and advantages of wood screw anchors.

No. 548. BLOWERS: Roots-Connersville Blower Corp., Connersville, Ind. 4 p. bulletin on "Victor-Acme" rotary positive blowers for pressure or vacuum service, explaining construction, characteristics, and giving capacity tables.

No. 549. CONTROL VALVES: John G. Kelly, Inc., 210 E. 45th St., New York, N. Y. 4 p. folder on "Lawler-Kelly" control valves, for automatically regulating hot water heating system according to heat requirements.

No. 550. DRIVES: Gates Rubber Co., Denver, Colo. 48 p. guide for selecting or designing V-belt drives, including information on care of drives, catalog of equipment, numerous tables, diagrams, and technical information.

No. 551. DRIVES: U. S. Electrical Mfg. Co., 200 E. Slauson Ave., Los Angeles, Calif. 12 p. booklet and supplementary bulletins on "Varidrive" motor consisting of squirrel cage motor, and a variable speed differential by which speeds may be increased or decreased during operation to any rpm over a wide range; equipment is described, applications and remote control discussed; a special bulletin describes the driving of ventilating fans by this method.

No. 552. DUST ENGINEERING: American Air Filter Co., 107 Central Ave., Louisville, Ky. 8 p. publication entitled "Dust Engineering" including information about air filtering, dust collection, and related problems.

No. 553. FANS: Edwin F. Guth Co., St. Louis, Mo. 20 p. booklet presenting information on combined fan and lighting unit, and stressing uses in connection with air cooling systems for improving distribution of conditioned air throughout a room or area.

No. 554. GATE VALVES: Lunkenheimer Co., Waverly & Beekman Sts., Cincinnati, Ohio. 8 p. circular on "King-Clip" gate valves, illustrating inside screw, outside screw and quick operating types in both iron body bronze mounted and all-iron patterns.

No. 555. GEAR MOTORS: Allis-Chalmers Mfg. Co., Milwaukee, Wis. 4 p. bulletin on "Gearmotors"—self-contained speed reducers with integral or attached motors, for providing speeds from 6.08 to 1165 rpm; can be furnished with any type a-c or d-c motor, various horizontal or vertical arrangements.

No. 556. HARD FACING: Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. 16 p. booklet "How to Make It Wear Longer by Hard Facing and Overlaying," discussing hard facing by arc welding, choice of electrode, types of electrodes and procedures for various operations.

No. 557. HEATING SURVEY: Gorton Heating Corp., Cranford, N. J. Survey and data sheet for use in connection with application of "Surevent" equalizing system for steam and vapor heating.

No. 558. HEATING EQUIPMENT: L. J. Wing Mfg. Co., 14th St. & 7th Ave., New York, N. Y. Miniature vest pocket catalog of complete line of heating, ventilating, blower and turbine equipment.

No. 559. HEATING SPECIALTIES: Hoffman Specialty Co., Waterbury, Conn. New trade price sheets on traps, supply valves, and other heating specialties, for heating contractors, obtainable from regular wholesaler source of supply. Also, 12 p. catalog of venting valves for one and two pipe steam systems, one pipe vacuum and air line systems.

No. 560. HUMIDITY CONTROL: Parks-Cramer Co., 970 Main St., Fitchburg, Mass. Issue of "Parks' Parables" devoted to automatic humidity regulation, discussing in interesting manner the application and accuracy of psychrostats in industrial humidification control.

No. 561. INSULATION: Johns-Manville, 22 E. 40th St.,

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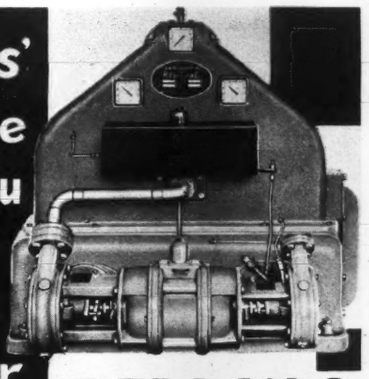

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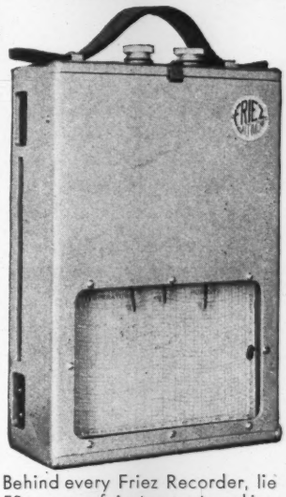

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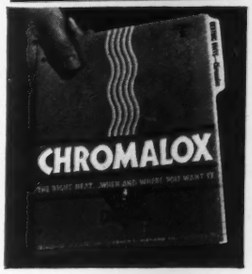

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No. 562. LUBRICATION: Imperial Electric Co., 52 Ira Ave., Akron, Ohio. Data sheet on lubrication of bearings in electrical machinery, including care of ball bearings, ten ball bearing "commandments," and pointers on sleeve bearings.

No. 563. PACKING: Hound Packing Co., 4757 Ravenswood Ave., Chicago, Ill. 12 p. booklet describing various types of packing.

No. 564. PROTECTIVE DEVICES: Willson Products, Inc., Reading, Pa. 32 p. loose-leaf catalog of industrial protective devices for head, eyes, nose and throat, including goggles, respirators, fume and smoke masks, welding and abrasive blasting helmets, etc.

No. 565. REFRIGERATION APPLIANCES: Fedders Mfg. Co., 57 Tonawanda St., Buffalo, N. Y. 40 p. bulletin of refrigeration appliances giving data on unit coolers, condensers, expansion valves, two temperature snap action valves, constant pressure valves, check valves, strainers, coils, and other products with information on applications, features, etc.

No. 566. REFRIGERATION SUPPLIES: Forslund Pump & Machinery Co., 3033 Main St., Kansas City, Mo. Loose-leaf catalog of over 100 p. of refrigeration supplies, accessories, and parts for air conditioning and commercial refrigeration and other equipment, including complete line of specialties, motors, pumps, filters, instruments, controls, etc.

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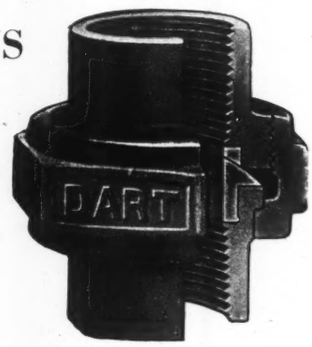

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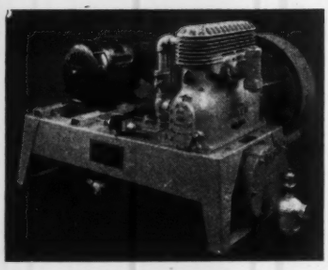

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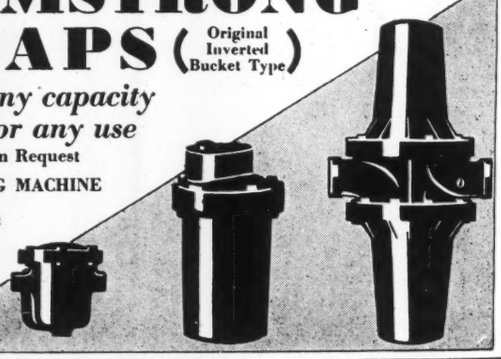

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No. 567. REGULATORS: Watts Regulator Co., Lawrence, Mass. Folders on pressure reducing valves, relief valves, and hot water heating regulators.

No. 568. UNIT HEATERS: The Myco Mfg. Co., 1120 Buhl Bldg., Detroit, Mich. 24 p. loose-leaf catalog giving descriptions and ratings of various sizes of "Wolverine" unit heaters. Also, 4 p. circular on unit heaters and silent automatic shutters (louvers).

No. 569. UNIT HEATERS: Thermidaire Corp., 2441 Charlotte St., Kansas City, Mo. Loose-leaf file of bulletins on propeller and centrifugal fan types of gas fired unit heaters, blast coils, fan furnace systems, boilers, and blowers and exhaust fans.

No. 570. VALVES: Edward Valve & Mfg. Co., Inc., East Chicago, Ind. Issue of "Valve Values" with discussion of extraction line valves.

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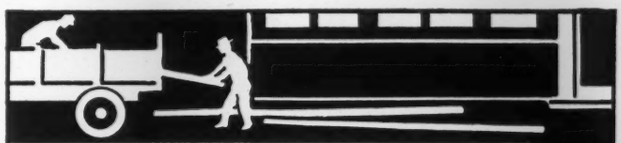

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